ON THE NATURE OF THINGS

BY THE SAME AUTHOR.

A SKETCH OF A PHILOSOPHY. In Four Parts. Sold separately. Williams & Norgate.

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THE FIRST LINES OF SCIENCE SIMPLIFIED AND THE STRUCTURE OF MOLECULES ATTEMPTED. Sutherland & Knox (1860).

ELEMENTS OF THE ECONOMY OF NATURE. (A Fragment.) Second Edition. Chapman & Hall (1856).

THE PHILOSOPHY OF THE BEAUTIFUL. With Illustrations. Edmonstone & Douglas (1855).

AN ENQUIRY INTO HUMAN NATURE. Sutherland & Knox (1853).

THE CATHOLIC SPIRIT OF TRUE RELIGION. Not an uniformity over all and everywhere, as attempted in the Church of Rome, &c. But unity in variety, as realised in the Creation, and in the Beautiful, is a constitution of the Church as a whole, answerable to the Present Epoch. Scott, Webster, & Geary (1840).

ON THE BEAUTIFUL, THE PICTURESQUE, AND THE SUBLIME. Scott, Webster, & Geary (1837).

A Science Primer

ON THE NATURE OF THINGS

BY

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WITH ILLUSTRATIONS

WILLIAM BLACKWOOD AND SONS
EDINBURGH AND LONDON
MDCCCLXXVIII

PREFACE.

THE primers, class-books, and text-books on all branches of science now publishing are, I think, calculated to do a great deal of good. They show how compendiously the most part of what is ascertained to be real and important in science may be intelligibly stated, and how interesting to minds of general culture an acquaintance with nature is when the statement of it is freed from the laboured scaffolding which usually surrounds it, and is deemed necessary to support it, in systematic treatises.

It may, indeed, be alleged that these primers present to their readers merely a smattering of science. But may it not with truth be replied, in similar terms, that the actual science of the day, in all its details, when viewed in reference to a satisfactory view of nature and its economy, is itself merely a smattering?

The following pages, which, to perpetuate a

title very general among the short treatises of the philosophers of ancient India and Greece, and familiar to us in Latin, I have named

"De Rerum Natura,"

are presented to the reader (who is not preoccupied and satisfied with science commonly so called) as appearing to their author much better calculated to satisfy that legitimate curiosity which the observation of nature and patient thought about it tend to awaken; and that for the following among other reasons:—

I. When in the progress of the development the field of physics and chemistry is reached, without the aid of the balance the specific gravities of masses and the atomic weights of their elements, their atomicities and chemical affinities, their abundance or rarity in nature, and their natural affinities have been deduced as functions of the form and structure of the least parts of matter; and the results thus obtained being thereafter compared with those of observation and experiment, such agreements present themselves on all hands as to constitute a striking verification of the theory advanced in its principal features, and in that branch of the subject—namely, the physical—which alone admits of a palpable verification; for what is advanced as to spirit and the world of spirits can commend itself to scientific acceptance only by its verisimilitude or general harmony with thought and things.

II. The train of thought is a cyclical development which, while it possesses continuity from first to last, is based upon a homogeneous unity into which it returns, with perfect conservation of energy and attribute; so that the popular view of things which looks only to a development all in one direction, issuing, in the opinion of some, in its own abolition and ruin, gives place here to a self-restoring, seed-producing system, homologous on the great scale with what we see in the small scale, and to what we should expect where immensity and eternity supply the field of existence and action, and the ever-living God is the Author of the economy.

III. Most of the views here advocated have been advanced in previous epochs of philosophy and science, but that only in broken and unconnected portions giving no mutual support, while here they are given in connection, falling into their places as parts of one systemic whole. And though the unhistorical and uncritical way in which they are here presented may seem disrespectful to modern science, and even revolutionary in some of its branches, yet on the part of an author whose home is far from all libraries, this was unavoidable; and if it be found on an adequate study of them that the changes proposed are all in the interests of objective simplicity, distinctness of conception, and facility of acquisition, with an ample responsiveness of nature, these literary faults may well be condoned.

IV. The author has extended the application of a law already familiarly known, but referred to in biology only, so as to be all-embracing and cosmical, and, indeed, as alone needed for the explanation of phenomena. And if he has succeeded, surely some such consummation is most devoutly to be wished. If it be said that he tends to make the science of mechanics coextensive with material nature, and to supersede chemistry except as an art; that he aims at presenting atoms and molecules, and ultimately tissues, as structures distinctly visible in the mind's eye, their modes of action, affinities, atomicities, and other affections being clearly explicable on well-known statical and dynamical principles, and their analysis and synthesis a sort of clearly-seen mental fingering,—surely this is a state of science against which the only thing that can be said is that it is not possible to be accomplished—an objection which only reminds one of the remark which Bacon somewhere makes, that he is a bad mariner who concludes that, when all around is sea to him, there is no land beyond.

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1. Existence, its characteristic is that which the word implies — viz., outstandingness, manifestive power.
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3. "Substance" differs from power or energy only as the statical, reposing, or potential differs from the dynamical, kinetic, or volitional. The last word is "thought," but it is a manifestation, not its source.

CHAPTER II.

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14. It is, therefore, a thing of grandeur and beauty—a cosmos; and assimilation is the law of the created substance. It is essentially assimilative.
15. The agency developing creation is an efficient or operative idea, a divine unity—not two separate things, the "idea" and the "power"—which realises it. This dichotomy is a product of our analytic habit of mind.

Hence it is not legitimate to insist on a mechanical continuity (pressure or traction with palpable contact) as the needful cause of all natural movements, such as gravitation, &c.

CHAPTER V.

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17. It is a thing of energy—an energy.
18. No attempt should be made to define the extent in space of an element of plasm or energy.

19. Energy is variously modifiable, as, for instance, into potential and kinetic, &c. It is also variously transformable.
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20. The cosmical law gives to the thread of embodied thought, as the primal evolution and state of the universe, the world of spirits, and as their home the realm of light or the universal ether.
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22. The cosmical law gives the phenomenon of *inertia*, commonly called the first law of motion.
23. In individualised portions of plasm it also maintains a self-conservative action and thus secures *permanent properties*.
24. It also gives isodynamic boundaries around a centre of force or energy, and therefore gives the phenomenon of *volume*.
25. By rarefaction, it gives dissociation, isolation, the aeriform state.
26. By integration, it gives sociality, attraction, concretion, unification.
27. It also provides for the redintegration of form and structure when those which are primal and natural have been departed from. It therefore gives the phenomenon of resilience, which may be either immediate and transient and is named *elasticity*, or subsequent and secular and is named *heredity*.
28. As to the form of an individualised object this cosmical law calls for *sphericity* implying cellularity as the culmination form.
29. And as the nisus at sphericity when it cannot be reached it provides for symmetry in general.

CHAPTER VII.

THE UNIVERSAL ETHER.

30. In virtue of the omnipresence of the Supreme Being, the cosmical law expands in space the universal ether.
The ethereal elements are the *minima naturæ*, and next to nothing. When in a state of repose their form is spherical.

31. Urged along one line, being purely plastic, they become first oblate, ultimately annular.
32. Then by reaction under the cosmical law and inertia they become prolate, ultimately spicular, then spherical again.
33. Hence three kinds of radiant action in the ethereal medium, one taking place at right angles to the course of the ray, the others in that course.

The velocity of this action is extreme, compared with that of all known bodies. But it is slow for the stars.

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34. Matter is molecular and multiple, mind or spirit is monadic.

The substance of creation when not attenuated and reduced to unities so weak as to be incapable of manifesting the full complement of the attributes of energy, is spirit.

35. Too weak unities when they integrate imperfectly by juxtaposition into molecules and not by fusion into monads, are inadequate to produce the phenomena of mind.
36. The place in nature of a molecular system is a necessity.
37. But nebular specks of ether in the celestial spaces may, by their centrad action, unify so much of ether as may form for them a nucleus. This nucleus, together with its genetic ethereal atmosphere, is the material element.

The material element in virtue of its differentiation is very stable and essentially active as to motion and form.

38. There is an alternative as to the structure of the nucleus.
39. This may possibly give rise to difference of sex.

Admitting this difference, all material elements are identical, except as to their positions in space.

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40. The construction of molecules is normally a process of doubling or coupling merely. But hydrogen may be generated other ways also.

The first molecular structure, consisting of a single couple or binary system of material elements, fails to fulfil the cosmical law (sphericity) so far that it is not found in nature.

41. Two couples or binary systems coupled symmetrically or cross-wise, fulfil the cosmical law, the nucleus being an elemental tetrahedron, its atomic weight = 4. It forms the basis of the molecular system—the tetrad.

It is undecomposable, though by extreme heat it may possibly be resolved or exploded into four single elements of matter.

It is essentially parasitic or adhesive to other matter, though, by extreme heat, all molecular matter may possibly be resolved into tetrads in the free or aeriform state.

42. Given in the same neighbourhood single material elements and tetrads, being dissimilar they will unite, and the hemiform (pyramid) becomes an isolable form (bipyramid). An atom of hydrogen results. Its atomic weight 4 + 1 = 5.

43. Four tetrads their faces fronting symmetrically the angles of a central tetrad at the same distance as their own opposite angles — that is, in harmony with the cosmical law, also constitute a tetratom of hydrogen. The equation being $5 \times 4\Delta = 4 \times 5 = 4H$.

44. The hexatom of hydrogen, a self-saturating molecule of hydrogen.

45. The hexatom differentiated by the poles (marsh-gas, alcohol, urea, &c.)

46. The hexatom differentiated on the equator also (chloroform, uric acid, &c.)

47. The hexatom preserved, but differentiated less or more or altogether (phosphuretted hydrogen, &c.)

48. Hydro-carbons of the more perfect type of marsh-gas, when broken down, assume a linear type, functioning like simple hydrogen (methyl, ethyl, acetyl, &c.)

The laboratory ammonias (methylamine, &c.)

CHAPTER X.

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49. The laboratory residua of living organisms; oxygen, hydrogen, nitrogen, carbon.

50. The least elements of living tissue are aqueous and ammoniacal vapours detained in the non-acriform state by carbon.

51. Organic life is a state of intimate movement in the organism more or less normal to it as such; and death is a cessation of that movement and a lapse into mere molecular action.

52. It is not organic life itself, but development under the law of heredity, that involves death and dissolution.
53. Organic life, and the economy of molecular nature generally, is not development all in one direction, but is cyclical.
54. The easily transformable and volatile elements of tissue (aqueous and ammoniacal matter) tend to keep up organic life, but that life tends to be quite ephemeral.
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75. Carbon, hydro-carbon, in the sky and in the strata.
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CHAPTER XII.

THE THEATRE FOR LIFE: THE OCEAN—THE AIR—THE SOLID SURFACE OF THE GLOBE.

79. The Ocean: Vapour-pressure gives water, water-pressure gives sodium and potassium, of which the latter when demetallised becomes chlorine. Hence sea-salt. Its specific gravity deduced.

80. The Air: Oxygen in single atoms can be protected from hydrogen and from lapsing along with it into water only by having on both its poles some such element as azote, which may be expected along with it in the abyss. Hence common air consists of one volume of oxygen gas (a couple of atoms) and four volumes of azote.

81. Rocks and Stones: When the heat becomes intense from intense pressure, all matter in the abyss will be dissociated into tetrads. These when pressed together must form into fixed molecules, among which the chief is one consisting of twenty tetrads. This molecule is secularly developed into bihydride of silicium, which on the access of oxygen gas gives silica and water, the principal constituents of the terraqueous globe.

THE SPECIFIC GRAVITY OF QUARTZ DEDUCED.

"Since the poles of silica are pentagonal, its molecule must be the dodecatom, which may, of course, be either differentiated as usual or not. Both occur in nature; but since coupled atoms of silica, in the first instance giving an atom of **O** in the centre and an atom of O on each pole, possess a structure so much more perfect than the single atom, it seems likely that natural molecules of quartz will thus consist of coupled molecules. This gives—

$$\left.\begin{matrix}\text{Quartz of}\\ \text{fusion,}\end{matrix}\right\} G = \frac{(OSi\mathbf{O}SiO)^{12}}{AQ} = \frac{12\times300}{1620} = 2{\cdot}2 \text{ Exp. } 2{\cdot}2.$$

$$\left.\begin{matrix}\text{Crystal-}\\ \text{lised}\\ \text{quartz,}\end{matrix}\right\} G = \frac{(OSi\mathbf{O}SiO)^{1+12+1}}{AQ} = \frac{14\times300}{1620} = 2{\cdot}59 \text{ Exp. } 2{\cdot}6."\ ^{1}$$

[1] See 'A Sketch of a Philosophy,' Part IV. p. 170.

PERSONAL NOTE.

THE Author desires to account for the obvious faults in the composition of this little Work by stating that, as he found his views extending and at the same time improving in unity and simplicity more and more, year after year, since 1830, when they were first propounded in a very immature state, he was tempted to put off the composition of this epitome too long (æt. 78). And when engaged in it he was warned of unfitness for sustained study, too soon to do it well, too late to refrain from doing it altogether.

MOFFAT, DUMFRIESSHIRE,
June 1878.

ON THE NATURE OF THINGS.

CHAPTER I.

INTRODUCTORY.

1. Existence, its characteristic. — That something exists is the basis of all knowledge, all philosophy, all science. And as to the characteristic of existence, or that which makes an object *to be*, it is enough for our progress if we regard it as that which the term itself expresses—viz., that which outstands; which can only mean that which manifests itself, that which is possessed of manifestiveness or a manifestive power. This in its turn implies, no doubt, a corresponding receptivity. But this is not a complication; or, if it be, let it be granted, for it is inevitable; and let us conclude that a manifestive power, with an appropriate receptivity, is the characteristic of existence or *being*.

2. A classification of existing objects.—This view of the nature of existence enables us at once to classify the objects of knowledge, of philosophy and science. No doubt such a step as classification cannot be taken without violating the continuity of all things; but it

is a necessity for the human memory in which knowledge exists only as a thread requiring to have knots on it, in order to be caught up as wanted.

Class I. Includes those objects in which existence, viewed in its characteristic, culminates—namely, those which are manifestive to the full, manifestive to themselves as well as otherwise, *conscious* as well as percipient and perceptible. These are Spirits or mentally endowed beings.

Class II. Includes those objects which are perceptible but not percipient; whose manifestive power invests them with impressiveness and impressibility only—viz., Bodies.

Class III. Includes those objects (maintaining the continuity of the cosmos so far as is compatible with their individuation) which intercede and mediate between spirits and bodies, and supply substance for constituting both—viz., Ethereal Elements.

3. The relation between substance and power or energy.—The nature of things now advocated, inasmuch as it holds that manifestive *power* is the criterion, the evidence, the essence of being, implies that that essence is power or energy. As to substance (another familiar term), it is not to be inferred that there is anything else in it. Substance is merely power or energy when conceived, as in a statical, quiescent, or potential, not an active, cogitative, volitional, or kinetic state; and it is to be regretted that in forming languages from the Latin, along with "existence" the term "sistance" was not preserved as expressive of the statical, the quiescent, the unobtrusive state of existence.

The last word in this field is *thought*. But yet thought vanishes under the attempt to conceive it as a being or thing in itself, or otherwise than as an efflorescence or function of something else.

CHAPTER II.

A SUPREME BEING.

4. Energy, when individualised and possessed more or less of its full complement of attributes, constitutes a spirit.—Of the three orders of being which have been indicated, plainly spirit is that in which the criterion of existence is most fully possessed. It is that in which existence is most perfect. On this ground, therefore, spirit claims our attention in the first place. And surely this claim should be welcomed by us; and that not only on account of its dignity, but because in all our pursuits we ought to come as near to our object as we possibly can. Now the object of science is knowledge, and it is by the action of spirit alone that we can know anything. Why not, then, a knowledge of spirit in the first instance? The answer is not a contradiction of the order just proposed abstractly, but merely an evasion in consequence of the difficulty of observing and investigating phenomena which are at once invisible and impalpable, as is the case with the phenomena of spirit.

5. The first of spirits is Infinite and One.—The idea of finite implies a boundary or limitation. Now this is a subsequent idea, implying that there is before it that which is unbounded, infinite in this case in all the attributes of a perfect spirit. Among these unity presents itself in the first instance, for two or more infinites

are impossible. Moreover, the constitution of intelligence itself, which is ever aiming at unity and identity, proclaims that at the fountain-head of thought and Being there is One, and not more than one.

6. Along with unity He possesses omnipresence and omnipotence.—The first specific object, therefore, of the philosophy and science which we advocate, is that Being whom all the human race is ever seeking, and who is most shortly named God. And here it is necessary to enter so far into theology as to affirm that not only is this Supreme Being One and infinite, but that He is also everywhere present, possessing throughout all immensity the characteristic of existence, self-manifestive power, implying power bounded only by what is self-contradictory or impossible, and therefore all that is rationally expressed in the idea of omnipotence.

7. He also possesses supreme happiness or ever-blessedness.—Without insisting on a demonstration or even an illustration here, it is necessary for our progress to state, and let it be granted, that when an omnipotent spirit is freely and fully outpouring itself in the normal exercise of self-manifestive power, without restraint or arrest, it is in that state of mental action which is familiarly known as happiness or blessedness. Now this is a state of mind for the sake of which alone, in a greater or less degree, existence, so far as we can see, possesses any value. If the consciousness of incongruity do not forbid, let us just suppose a universe filling all space it may be, but which all through and all over is wholly apathetic, with no one at all either over it or in it capable of feeling,—a universe, therefore, which could not be characterised either as grand or beautiful or by any other attribute implying sensibility either in the objects of it or the beholder of it, would it not be a most inane thing, nay, the very realisation of an abortion, on the largest possible scale? But there is

no such thing. In point of fact, feeling exists in the actual universe to a vast extent. And how could this be unless it also existed in the First of Beings? But if in Him it existed at all, we must regard it as existing in perfection, since He is in His every attribute perfect. Along with unity and omnipresence, therefore, we ascribe to the Almighty, ever-blessedness, and that not merely as a point of theology, but as a step indispensable to our progress, as will presently appear.

Though it is not necessary to our progress, it may be here mentioned that all the attributes of the Supreme Being which enter into theology, along with those mentioned above, may be reached as manifestations or developments of the attribute of almighty power. Thus, not only omnipresence but omniscience appears on this ground; for certainly, if in an almighty Being there were any points of darkness or ignorance, the first forth-putting of His omnipotence would be to light them up into perfect knowledge, and thus to provide Himself with omniscience. But the knowledge of all things implies also perfect knowledge of their right relations. Thus, omnipotence implies a perfect knowledge of rightness or righteousness. And on the supposition of a change among these relations, it still implies a perfect knowledge of the forthcoming relations contemplated. But this is perfect wisdom. An omnipotent Being, therefore, has a knowledge of perfect wisdom. And these attributes, when informing His will, imply that He is perfectly righteous and wise, no less than supremely actuated by love, as will be presently shown to be implied in His ever-blessedness. And so on in full detail.

CHAPTER III.

THERE ARE REASONABLE GROUNDS FOR A CREATION OF BEINGS CAPABLE OF ENJOYMENT.

Suppose a mind or spirit to be every way perfect within himself, as we have supposed the Divine Being to be, it is not easy on first thoughts to see how he could be led to award existence to anything such that it was not either himself or wholly his own. As in a perfect mind all possible systems of thought, the scheme of every possible universe, must present itself in the clear light of pure unencumbered idea, in one boundless panorama, at once revolving and simultaneous, may it not be asked, What could be better or so good? Why award existence to that which, being finite, cannot but be comparatively defective, and in fact an intrusion upon that which is more perfect without it? Such thoughts suggest difficulties as to a creation. They suggest Pantheism, which maintains that all that exists has existed for ever, and that a belief in a creation is a mistake. Now this is a view of things which merges all moral distinctions, and, instead of being a solution, is merely a dissolution of all important questions. Let us see, then, whether there are not reasonable grounds for a creation, at least of a certain kind, or with certain contents and characteristics.

8. Perfect blessedness is essentially extensive or communicative, and develops into benevolence or love.—Personal or private happiness arising from the spontaneous and unresisted flow of self-manifestive power is such a state of mind that it tends to go ever on and to seek a medium beyond itself which (under the cosmical law, see Chap. IV.) it may assimilate to itself in this respect. For this the only evidence accessible to us (exclusive of the cosmical law) is indeed the conscious or observed disposition of the human mind when it is itself in this happy state; but in the circumstances this ought to be held sufficient.

The ever-blessedness of the Supreme Being, therefore, occupying immensity internally tends to manifest itself externally also, or somehow beyond the Divine mind itself. But the existence of happiness anywhere implies individuality there. Where one only exists one only can be happy. The ever-blessedness of the Almighty, considered as existing alone, leads us therefore to infer a disposition in Him to award existence to other individualised beings with a view to their happiness also. Thus, in the permanent wellbeing of the Almighty as to feeling, even in His own ever-blessedness, divine love is co-eternally or before all worlds implied.

Here, however, a limitation to ever-blessedness or permanent enjoyment in creatures presents itself, which, in so far at least as creatures possessing definite forms are concerned, it does not appear how even omnipotence can remove.

9. The antithetic relationship of space to time imposes limits on beneficence.—A multiplicity of individualised beings capable of feeling being supposed, it is important to remark that restrictions on their enjoyment emerge from the very conditions of their existence. Thus, that there shall be room for them, that they shall exist in space, is unavoidable. Now

this room, this space, be it what it may, is wholly inexorable to the most benevolent designs. It is absolutely stereotype to its own laws, and imperative that everything which enters its domain shall obey these laws.

Moreover, it is to be remembered that in the case of sentient beings there is another condition of existence also, namely, time. And although in philosophical treatises time is usually presented along with space as if it were co-ordinate, yet here at any rate we must remark how completely space and time differ. Unlike space, which we cannot but conceive as everywhere present and everlasting, time exists only where there is change, and is indeed merely a generalised conception of change, affirming change all irrespective of what is changing. Time is not, therefore, a condition of existence with respect to all individualised objects. Provided these objects themselves and the whole horizon of their existence be perfectly still and unchanging there is no field for the consideration of time. It is only when change occurs that time emerges; and by that change it is constituted. Time, therefore, is in its origin and nature antithetic to space.

Now life in its very essence and all its phenomena is a continual succession of changes. Consciousness is merely a changeful acknowledgment of changes, and so is all feeling and every mental function. That a material organism may live, it will also in due time appear that changes must be continually going on in it.

Here, then, in the very nature of things, we are led to anticipate some of the most striking issues that the actual creation displays, such as death along with life. As used popularly and theologically these terms do not indeed express the phenomena themselves so much as the happiness or the suffering usually associated with them. When thought of in themselves, life and death

change their aspect very much. They do not imply any defect or degradation of creation. They merely imply that its economy is not purely continuous, but is cyclical. As might be expected in the creation of an ever-living Creator—unless we regard space as something—there is nothing in the universe that is everlastingly dead. The incidence of death on structures which are essentially transient is not an evil. It is the suffering which is the usual harbinger of death and usually accompanies it which has gained for death the name of the "king of terrors." And now we are in a position to understand how there may be such a state of things without any detraction from the perfect goodness of the Creator.

10. Hence, unavoidably perhaps, in creatures occupying space, suffering along with enjoyment.—From what has been advanced it appears that the properties of space and those of any individualised being whose wellbeing or enjoyment implies change (as, for instance, the exercise or development of its own self-manifestive power) are essentially antagonistic. Space is immobile and indivisible. Perfect and imperturbable stability and repose are its characteristics. And hence everything which is to exist in space, if it is to be in harmony with its place in nature, must be stable, and, if not stable already, must be ever tending towards stability. Now this stability exists in the mineral kingdom, and the tendency towards it is illustrated by crystallisation. That self-manifestiveness, on the contrary, of which the wellbeing constitutes enjoyment, is a continual changefulness, instability, restlessness, and motion. There is, therefore, a constitutional antithesis between the nature of space and the nature of enjoyment. And since space cannot be willed out of the way, nor enjoyment made to be another thing than it is, even by Omnipotence, there is already ground for the apprehension that there may

be much suffering in a world teeming with sentient creatures existing in space. And should such suffering be met with in such a creation, it does not prove any defect either in the wisdom or the goodness of the Creator; nor does it need, in order to explain its existence, the violation of His laws. In such creatures, simply because of their situation in space, a liability to suffering is a condition of their existence. And thus is a basis laid for theodicy as a branch of science.

11. This liability to suffering is not to be regarded as a limitation of power in the Creator.—The properties both of space and time are aboriginal. They are indeed manifestations of the Divine mind itself in these respects. No one insinuates that the principles of geometry and the calculus are limitations of power in the Almighty. Now it has been shown that it is out of these principles, when embodied in material organisms, that suffering may, if not must, emerge. Let not any one, then, who feels himself on other grounds called to the love of God, permit any abatement of that love from what he sees in the creation, in so far at least as the observation of suffering in general is concerned. In order to the existence of enjoyment in localised organisms it may be inevitable.

12. To suffering, which is consequent on the violation of law, no reasonable objection can be taken.—There are, however, many forms of suffering between which and space, with its inexorable demands, no relation whatever can be discovered. But such cases are always violations, either conscious or unconscious, of some appointment or law of the Supreme. Theologians do indeed often maintain that in consideration of its value as discipline, as a means of raising the sufferer to a higher state, suffering is consistent with perfect goodness even as a direct infliction by God, and although neither ignorance nor guilt on the part of the sufferer

has had anything to do with it. Now, no doubt, to bring good out of evil is the very characteristic of God. But it is not admitted that any one may do evil that good may come. And it cannot be denied that suffering is an evil.

As to the possibility of suffering in consequence of the violation of law, that is implied in the very idea of a law which may possibly be broken, if without a penal sanction, there is not a law, but merely a dictate or advice. And for such laws as those, on the fulfilment of which the order and wellbeing of the universe depend, it is plainly a needful and a right thing that the penal sanction should be severe.

It is also plainly necessary, that in an economy administered by law, the penalty of violation should fall upon the violator all independently of his knowledge or his ignorance of the law which he may have broken. Even in mundane legislation, ignorance of a law is not admitted as an adequate ground of pardon for breaking it, although in this case pardon is far more easily exhibited than punishment; while in reference to the laws of nature it is entirely the reverse.

We maintain then, that, so far as appears, there is nothing yet to contradict the belief that universally the design of creation is the institution and maintenance of a system of things best calculated for *the wellbeing of sensibility* wherever it exists—*that is, happiness* to the full extent that the unavoidable relationship of time and space, energy and a specific form, life and death, will permit.

CHAPTER IV.

THE GRAND LAW OF CREATION: ASSIMILATION.

In the actual state of science the mind of the student is quite bewildered and burdened by the multitude of laws of nature which he has to learn and to commit to memory. Some of these laws claim to be rational—that is, in harmony with the laws and expectations of reason itself; others are merely empirical—that is, generalisations obtained from the observed phenomena, with no claim but this, that the related phenomena are supposed to imply as much. In these circumstances, it cannot be denied that it would be a great step in science if it could be shown that these manifold laws admit of being resolved into one another; and still better if into laws more general and therefore fewer in number; and best of all if into one grand law! After the shock which the very thought of such an attempt could not fail to give to adepts had passed away, it could not be denied that such a step in science would be a step indeed. Something of this kind is claimed in that view of the nature of things which is given in this primer, the reader being referred for detailed illustrations and verifications to another work. Meantime here is the cosmical fact or law:—

13. Creation is a medium to embody, a mirror to reflect, the will (that is, the being and attributes considered as active) of the Creator.—Since existence is a

self-manifestive power, and before creation the Creator alone existed, how could it be otherwise than that creation should manifest His being and attributes as active—that is, His will? To an all-seeing eye and perfect intelligence, the being and attributes of the Creator will assuredly be reflected in creation as in a mirror, which, however, being finite, cannot, even to Him, fully represent His mind. As to such defective beings as we are, ever prone to swing from credulity into unbelief, it may be most truly said that—

> "Blind unbelief is sure to err,
> And scan His work in vain.
> *God is His own interpreter,*
> And He will make it plain."

14. Creation must be a thing of grandeur and beauty, a cosmos.—This, however, we may at once safely conclude that creation must be a thing of beauty and grandeur, and so may be well named a cosmos. And adopting a term already in familiar use to signify that process by which the growth and wellbeing of our organism is secured as long as life lasts, we may say that the law of the creation is ASSIMILATION. And in harmony with this one idea alone, and as its produet under those attributes of the Creator which have been adduced (Seets. 5 and 6), it is here proposed to explain all the phenomena of which an explanation has been hitherto attempted by invoking the aid of many laws, both rational and empirieal, and of others as well which have hitherto been left to stand over as unexplained or inexplicable.

15. The productive and conservative agency in creation as it exists and acts, does not consist of two things, "idea" and "power," but of a unity embracing both, for which there is no special name.—Here let it be confessed that the relation between the Creator and

the creation, the First Cause and what He has effected, is altogether inscrutable. When it is said that God made all things of nothing, the meaning can only be that nothing was there (except of course Himself) before He made them. Intelligence, however, acting analytically as it cannot be kept from doing, insists on these two elements in the problem—viz., *idea* and *power*. But it is desirable here to remark that this separation of agency into two betrays the analytical and dichotomising tendency of the embodied mind, with neglect of subsequent synthesis and reversion to a unity. Instead of idea as regulative, and power as effective, it is desirable to think of efficiency in the idea itself, and to admit such a conception as *operative idea*. No doubt this is an obscure and unsatisfactory conception. But it is useful if it exclude, as it is meant to do, the hypothesis which ocular observation, grown into a habit, tends to insist upon in most minds—namely, that motion can only be effected mechanically—that is, by pressure or traction or contact of some kind. The utter helplessness of such a hypothesis to explain many, even familiar, movements, fully appears. Gravitation itself, the grandest and most prevailing phenomenon of the material universe, has set all genius at defiance when attempting to conceive a mechanism which might account for it. But when we look at it in the light of the cosmical law, as operative in its own way—that is, as an influence or tendency to assimilate, then this most grand phenomenon presents itself just as one of a thousand others, being merely the tendency of two or more atoms or masses of atoms to be assimilated as to the place they occupy—a view which, moreover, as I have elsewhere shown, gives also the mathematical law of the phenomenon.

CHAPTER V.

THE FIRST LINES OF THE COSMOS.

SINCE the characteristic of existence is manifestive power, it follows that existence is a power, a force, an energy. And since the law of the cosmos is assimilative action, and its chief end the extension of thought and feeling in a state of wellbeing—that is, enjoyment which implies individuality in the subject of it, the synthesis of these ideas gives the following as the first lines of the cosmos.

16. The created substance in itself must be a purely plastic element—a true protoplasm.—The substance of creation, viewed in itself and apart from the action in and upon it of the cosmical law, must be wholly amorphous or indifferent as to its form, and perfectly plastic, a mere and pure plasm,[1] so that if the term had not been already appropriated to signify a substance, which is indeed a product of assimilation to the primal substance, but far from the fountain-head, the primal substance might have been called protoplasm.

If it had been otherwise, if the primal substance had been endowed with permanent properties of its own,

[1] This conception is to be found well expressed in the opening of the Doric Tract of Timæus Locrus, περι ψυχᾶς κοσμω και φυσιος, which is so much nearer the truth than Plato's own Timæus, that it is difficult for me to believe that Plato was the real author.

there would have been no field for the operation of the cosmical law. There could have been that which, whatever might come out of it, would have been beyond the control of the Creator, except by the forthputting of His power as special miracle. Now, however prevalent such a conception of creation may be, it presents insurmountable difficulties to all sound theology and scientific progress.

17. It is a thing of energy.—It has been shown from the characteristic of existence that the substance of creation, viewed generally, must be an energy. When it is conceived, therefore, as individualised or partitioned, every element of it must be a thing of energy. And with regard to the amount of energy in each, the simplest hypothesis, and that which is alone in harmony with the cosmical law, is to the effect that the amount of energy in each individualised being or thing is assimilated to the quantity of substance in each—the amount of energy being estimated not merely by units and increments or decrements of force of the same kind, but also by the higher or lower attributes of energy, as for instance, mental attributes as the higher, merely mechanical attributes as the lower, manifestations of energy.

18. No attempt should be made to define the extent of an element of energy.—Here let us caution the student, while we speak of quantity of energy, to keep altogether away from his mind all ideas of a measurable volume proper to that amount of energy as including the whole of it. These two things our habit of observation by the senses tempt us to associate together, and to regard as equally definite and parallel. But from the conception of an element of energy, whether more or less powerful, the conception of size or volume or absolute limitation in the space which it occupies, should be carefully excluded. Happily for this purpose the popular conception as to the extent of universal attraction

will suffice. Thus it is popularly held that every atom of matter extends as an attractive agency to the extreme horizon of the solar system and to an unknown distance beyond. Let the same extent be granted to every element of plasm as an agent in the cosmos. Or rather, let no attempt whatever be made to ascribe to an element of energy, whatever its amount, a limited volume within which alone it exists as a power. Its centralised manifestation or centre of energy or force is all that we can discover, with increments or decrements around that centre as we recede from it.

19. Energy is variously modifiable and transformable, the extremes being mental energy on the one hand and material energy on the other.—We have already seen the tendency of energy to manifest itself in couples, as for instance, statical and dynamical, or potential and kinetic, as also within the same sphere, positive and negative. Nor is it a less eminent feature in the economy of the cosmos that when the proper conditions of existence arise, each form of energy shows itself capable of transformation into another that is equivalent. On this the variety in the unity, the unity in the variety, in a word, the harmony and beauty of the cosmos mainly depend. But here it is important to remark that the pair in which this functioning of energy culminates is not merely the development of couples in the same sphere, such as statical and dynamical, &c., but into the extreme pair of mental, that is, feeling-and-thought-producing energy on the one hand, and material or motion-producing energy on the other; the basis of the former being the monad when constituted by an adequate store of energy, and the basis of the latter being the molecule-forming atom—two modes of being differing remarkably not only in their functioning but in their destiny in the cosmos; the monad, the mother of mental energy, being a true unity not subject to dissolution and naturally im-

mortal, the molecule, on the contrary, decomposable and subject to manifold changes of properties.

20. As the first state of creation, the cosmical law gives the world of spirits and the universal ether or realm of light.—As to the form, structure, and distribution of the whole of the substance of creation, viewed in its normal and primeval state and its most general features, what we are to expect under the cosmical law, is assimilation to the Creator in respect of these two seemingly antithetic attributes—His unity on the one hand and his omnipresence on the other. Now these attributes viewed as imminent and operative in the cosmos, and constitutive of beings who shall be capable of enjoyment, and who must therefore be individualised beings, give in the first place a series of beings graduated so as to violate as little as possible the law of continuity (implied in the Divine unity viewed in relation to time), that series consisting, nearest the Creator Himself, of beings of the highest endowments and therefore Spirits or intellectual and immortal beings; but also in the second place, in virtue of the omnipresence of the Creator and under assimilation to that attribute, falling away (since the quantity of created substance is finite and space or immensity infinite), until each individualised element has been attenuated to the utmost and has become next to nothing, thus answering the conception of an element of ether!

Our method of the development of the cosmos, then, by reference to the attributes of the First Cause, gives us simultaneously a hierarchy of spirits constituting a world of spirits, and along with that world, diffused through immensity to the utmost, a most rare medium in which these spirits may live and enjoy their life by reciprocal assimilation or communion, for which the ether must be eminently suited; its elements, no longer able to see and so to spend energy on themselves, but yet of a spirit-

substance and well fitted for forming a medium of vision, thus assisting others to see.

Now, however contrary to the spirit of our day, the method of developing the first lines of nature from the attributes of the First Cause may be, however many men devoted to scientific research there may at present be who give no place in their minds to a belief in a world of spirits or who still have doubts even as to the existence of the ether, it is not to be forgotten that observant and reflective minds from the most ancient epochs have generally believed in both; so that, viewing this chapter in the light of the history of philosophy, it has a standing of which neither the author nor the thoughtful reader need be ashamed.

21. The economy of creation implies an opening for miracles.—According to the view which has just been given, both the world of spirits and the universal ether, or realm of light, are the immediate creation of the Almighty, who has constituted them so that they may be manifestations of His will and mirrors of Himself, in so far as the finite can manifest and mirror the infinite. But in reference to such a matter are we right in using the past tense, and in speaking of creation and its economy as that which has been rather than that which is? If the Creator be and has been almighty in all past time and from all eternity, He is also ever-present and ever-living throughout the universe, ever imminent to all that exists. Since, then, the individual spirits in the world of spirits, and the elements of ether constituting the realm of light, exist with nothing between and in all possible continuity with the Divine mind and will, we are called upon to regard that mind and will, not as standing apart, but as normally and naturally in intimate relation with every individual spirit and with all the elements in the realm of light, so that He, as it were, always touches them and they

always feel His touch. And any movement in His will, if He proposes that it shall affect, be it an individual spirit in the world of spirits or a special field in the realm of light, or special element of ether, or some of its phenomena, shall do so normally, naturally, and as part of the economy of creation. Now when we reach the existence of matter we shall find that the atom is a product of ether, its dynamisphere still an atmosphere of ether investing a nucleus of unified ether. In virtue of His relation to the ether, therefore, which is as His immediate breath, the Divine will bears normally and naturally and in the economy of nature upon matter. Those unusual and striking occurrences, therefore, which go by the name of miracles, in which something takes place contrary to what previous observation led to expect, are not interferences with nature, much less are they contradictions of it. They are simply manifestations of the same mind and will as conducts nature usually in a uniform course without them. Nature usually proceeds in a uniform course for the same reason as it, on singular occasions, supplies unusual or striking phenomena or miracles—namely, that on the one hand, by its uniformity it may be answerable to the perfect and perfectly foreseeing intelligence of the Omniscient, and on the other to the finite intelligence of creatures who need to be reminded of the Divine liberty and power to act and to manifest Himself as he may please. There is no logical or scientific warrant for affirming that the uniformity of nature never is nor can be departed from. True, when now we observe the commencement of a phenomenon which we have seen completed in our previous experience, we expect it to be completed now as it was before. Both as to time and space, the law of assimilation leads us to infer identity so long as no difference appears, and this being a cosmical law leads other creatures to do so as well as our-

selves. A dog which has been previously beaten howls when a whip is held over him. And in virtue of the same law most creatures are easily lured by baits or objects between which and others that have served as food for them previously they see no difference. Now this is all the basis on which an inexorable uniformity in nature is affirmed by many men of science, for history is quite against them.

Besides, wherein does a miracle differ from the ordinary course of nature but that it is unusual and striking, and striking because it is unusual, and therefore calculated to arrest the attention and fix it on the lesson accompanying it or implied in it? I know nothing (said once an intelligent friend to me when eating an egg) in that class of things which go by the name of miracles that is really more miraculous than that an egg, such as I am now eating, should merely, by being kept for a certain number of days at a moderate temperature, change into a feathered fowl and run away from me in a fright under the wings of the fowl that kept it warm.

CHAPTER VI.

THE MODES AND LIMITS OF MOTION AS DETERMINED BY THE COSMICAL LAW.

Passing by for the present the highest functions of energy—those, namely, which constitute mental phenomena, perception, feeling, thought, and volition—let us here proceed to develop those which are commonly designated as physical, and which have forms and movements for their object,—not because the latter are either more important or more interesting, but because they are more in popular favour at present, and their exhibition is more easy, and because they open more directly into molecular science, where, I believe, there occur, step after step, such verifications of the views here advanced that I cannot but regard it as certain, that in their principal details they are representative of the nature of things in many important particulars, and give an insight into the structure and economy of nature, which will be one of the highest enjoyments of life to future physicists and chemists, as it has long been to myself, and is now. The view here advanced was not possible to be verified until the atomic theory had been brought to the state in which it is now. And that it should not be known or received, except by slow degrees, the whole history of science leads us to expect. Happily the private delight

of increasing, ultimately satisfying, insight, is reward enough for the greatest discoverer. Let us, then, passing by for the present the phenomena of mind, proceed to develop the laws of motion and form as they emerge under the application of the cosmical law to the elements of the substance of creation or plasm.

22. As to locomotion: inertia.—Suppose a mere element of plasm existing in space not actuated by itself from within nor by anything from without, then, whether it be now at rest or now changing its place, the cosmical law requires that in the next moment it must assimilate itself to what it is or is doing in the moment now extant: if now it be at rest it must continue at rest; if in motion it must continue in the same motion. Now that motion viewed in reference to an instant or moment of time is a change from one point in space to the next point adjacent to the first; and this is and cannot but be an element of a straight line lying in a certain direction; and so—in virtue of the law of assimilation—with all the succeeding elements of motion they must all lie in the same direction. The motion considered as a whole, must therefore be straight or rectilinear. Moreover, all the elements of motion are accomplished in equal times. The velocity of genesis of the motion, therefore, more shortly the motion itself, must be uniform as well as rectilinear. Now this is what has hitherto been designated as the first law of motion or inertia, and which has proved to be of the greatest value in astronomy and mechanics generally. It has, however, hitherto been considered merely as an empirical fact or institution of which no rationale could be given, a view which has induced some physicists of late to regard it as an inconvenience in rational mechanics and to ignore it. But we see that it is merely a uniform phenomenon—one of a thousand—resulting from the cosmical law.

23. As to individuation: permanent properties.—In the mode of motion just laid down it is implied that in the object which rests or moves, there exists a power of assimilating itself to itself as it is or acts in successive moments of its existence, and that for ever, unless it be changed. Now this is precisely a self-conservative power, an individuality-and-species-preserving power. It forbids, to an extent proportional to the energy of the object considered, the absorption or fusion of that object with others, or its being confounded with them. In a word, it implies permanent properties in every object that is and acts and does not tend to change from the reaction of its own parts, if that object be let alone.

24. As to volume: isodynamic boundaries.—Let us here remark that each individualised object has an appropriate sphere in space which may be regarded as its own, and from which other individualised objects, of the same kind, at least, are excluded. And hence the familiar idea of size or volume. Except for economic or experimental purposes, however, this matter of size or volume is generally misunderstood. Thus with regard to an element or a mass of matter, it is generally thought to be something small or large as it appears to the sight or the touch, with nothing of it at all on the outside of its visible or tangible boundary. And no doubt such information as to the visible and tangible dimensions of objects is most useful. But cosmically and scientifically considered, these limits of objects indicated by the external senses are only the isodynamic, not the absolute, boundaries of these objects. They indicate the region all round their centre, axes, or medial planes, where they manifest their presence to the senses of sight and touch. Their boundaries in reference to the sense of smell may be very different. And indeed the boundaries of an object as given even by sight and touch together do not always coincide. Thus one heavy body,

as, for instance, a ball of metal, may be made to rest upon another, as, for instance, a plate of metal, while yet light will be seen to pass between them at the point where the one rests on the other. Thus following, as is usual, the sense of sight, the observer is tempted to affirm that though the one is resting on the other, still they are not in contact. And in this way there arise in science many puzzles and paradoxes, good for feeding the popular demand for wonder, but very detrimental to the progress of true knowledge.

The isodynamic boundaries of objects commonly regarded as their external forms or volumes are at best only guides to the position of their palpable parts. The true boundary of any individualised thing viewed as an energy, that is, viewed in its true nature, cannot be discovered were it only because it is so remote from its centre. This may seem a strange statement; but it is in reality nothing else than what is commonly believed. Thus it is commonly believed that every atom of matter in this planet, and every atom in the solar system, acts on every atom however far away as luminous or illuminated objects they may be from one another. Now what is such a belief but a concession of that illimitable agency, that widely extended energy around every centre of energy, which is here affirmed? The popular belief that the true boundaries of things are the limitations of these which the eye gives, not only creates the puzzle of *actio in distans*, but sadly violates the highly favoured law of continuity, demanding as it does the belief of something on one side of a certain boundary and of nothing at all on the other side, a step in thought which for my own part I find it difficult if not impossible to take.

25. As to rarefaction: dissociation, isolation, the aeriform state.—Before proceeding further, it may be as well to recall to mind that inasmuch as the extension

of enjoyment is the main aim of creation, and that a recipient of enjoyment must be an individualised being or thing, so are we to expect in creation, *multitude*. Now, to effect expansion to the utmost, the cosmical law gives the imminence of the First Cause as present throughout immensity, and therefore as active to assimilate the substance of creation to Himself in this respect. But being finite in quantity, that substance, after accomplishing a certain expansion towards filling all space, must undergo partitionment. Nor does any limit to this dissociative analytical tendency appear until the elements of plasm have become *minima naturæ*, elements of being as small as possible. But however small in quantity and in energy, each element will still be able to assimilate itself to that attribute of the First Cause which is co-ordinate with His immensity, namely, His unity. Each element will be a truly individualised thing, tending to possess permanently its specific properties. Now, of these, its proper volume will be one; nor will any one, if not urged, tend to encroach upon the volume of another; for they are all similar to each other. They have all fulfilled the cosmical law to the same extent. They cannot, by their coalescence or union, fulfil that law to a greater extent than they have done already. They will therefore each tend to maintain its own portion of space; and under pressure together they will, as is commonly said, repel each other. And so with regard to individualised elements generally, atoms and molecules, when they are in free juxtaposition and assimilated or similar to one another.

But if they are dissimilar, and if by their coalescence the cosmical law may be further fulfilled, then, instead of reciprocal repulsion, interpenetration may be expected, of which the limit is, in the language of Dalton, that they shall be as vacua to each other.

This paragraph proceeds on the supposition that it is

action tending towards the fulfilment of natural law that keeps nature agoing; and that when an object has fulfilled all the natural law with which it is in relation, it becomes a *quasi* universe to and in itself, and has a definite portion of space assigned to it as its legitimate field of existence, into which others in the same condition cannot intrude spontaneously. This may make this paragraph seem more objectionable on the ground of its mysticism than the other paragraphs of this work, though all have a burden to bear in this respect. But it is believed that this objection will vanish when it is seen how satisfactorily it explains the varying amounts of activity manifested by different objects in nature, of which, in the actual state of science, no account can be given at all. For what has been laid down implies that objects in general are active or changeful in proportion to their crudity or their distance from having fulfilled natural law hitherto. Why, for instance, is oxygen so active as compared with azote? It will appear as we proceed that it is only and all because the form and structure of the atom of oxygen are much farther away from that form and structure which the cosmical law prescribes as the culmination of molecular action than are those of azote. Oxygen has much more work to do before it has fulfilled the design of nature. It is therefore much more active and urgent to do it.

26. As to integration: sociality, attraction, concretion, unification.—Since the First of Beings, the Author of all, is a unity, it follows under the cosmical law of assimilation that, along with a tendency to the utmost possible diffusion and the individuation of each element, when all have fulfilled the cosmical law and been assimilated to each other, and become as omnipresent as possible, that there must be at the same time in all, when occupying different positions in space, a tendency to come together into one and the same place. Now

there is no phenomenon in the cosmos that is more conspicuous than this. It manifests itself in universal aggregation and sociality, in consecutive polarity, in chemical affinity, in cohesion and fusion, &c.

As to gravitation, that tendency in atoms and masses considered as possessing inertia, when they are at such distances as are visible and the intervals between them capable of being measured, it is of all phenomena, both in nature and science, the most important. Manifold have been the attempts to explain it mechanically by traction or pressure, the familiar causes of locomotion. But these attempts have all been quite unsuccessful, if not also fantastical. It is time for science to content itself with ascribing such a phenomenon to a design in the cosmos, rendered operative in some way which transcends mechanism as commonly understood. For my own part, I am much better satisfied with ascribing it simply to the operation of the Will of the Author of all. When seeking for a unifying apparatus of an atomic structure to explain universal gravitation, one is receding from the source of information, not approaching it. To find a first cause for motion, one must, in every case, in the last resort, come to Will, that is, to mind. Now nothing can be more consentaneous to mind than a tendency to universal unification. To aim at unity, carried even to the length of identity, is the very characteristic of mental action. This tendency is not manifested in material nature for the first time. Material nature in this respect, as in so many respects, is modelled after mind as its mould. If there be Reason in nature, a belief which with some meaning or other is universally admitted, then a most comprehensive demand for unity is precisely what is to be expected. Not but reason tends to separate again the thoughts and things which it has brought together, and to examine each in detail now viewed in its known place in nature. Mind is

analytical as well as synthetical. And just so with regard to the cosmos, as has been shown.

Gravitation is not the last word of nature and science. Its operation is not to leave the universe in the lurch at last one vast dead mass, as some physicists apprehend. Co-ordinate with the tendency to fall together throughout all space and time, there is the tendency to the utmost possible separation and diffusion through all space and time. The fall together awakes a separative action (heat), whose function is not exhausted until an aeriform state, nay, the former nebula, nay, the original ether, has been restored, the falling in meanwhile going on simultaneously in other elements of matter. Development is never universally all in one direction, but in two opposite directions, which, taken together, are conservative of the cosmos, as assimilated to the Creator, who never dies but liveth for ever. There is no danger of the cosmos rushing spontaneously into ruin at last. Each separate star, like every individualised being or thing that has had a beginning, may also have an end. Perhaps it could not be as a created thing on other terms. But as to creation, as a whole, in some form or other manifesting the Almighty, it can never be a ruin. And indeed, even in the midst of the chaos of modern science, it may be gathered that the economy of nature is truly cyclical, competent in its own working for developing new life and new beauty, evermore expressive of the inexhaustible resources and will of Him who presides over all.

27. As to redintegration: elasticity, heredity.—The cosmical law of assimilation operates, not only in reference to space, but in reference to time as well. It tends to assimilate forthcoming states and structures to those of the same order that have gone before them. Of this mode of action memory is the most perfect example. But it has a signal place in the merely

physical and molecular, as also most eminently in the organic sphere.

Its most simple illustration is its immediate action where it restores a form which has been deformed, constituting the phenomenon of resilience, and, along with inertia, that of elasticity.

It also acts secularly as well as instantly, thus giving rise to the phenomena of heredity, and developing individual structures and functions assimilated to those that were antecedent, the continuity being usually maintained by memorial elements, germs, seeds, or ova, microscopic mirrors impressed by assimilative traces of the structures which produced them, and to which they, in their turn, tend to become assimilated when growth is permitted, though with variation implying comprehensive and not merely individual mirroring and a nisus towards a more perfect form and structure than that of ancestors, as will presently appear.

For this action of the cosmical law in reference to time or the history of objects, there is no term in use that is sufficiently comprehensive. The terms memory and habit belong exclusively to psychology, the term heredity to biology, and resilience and elasticity to physics. Meantime, let it not be supposed that it has no hand in determining the phenomena of chemistry, though it has no name, nor has, indeed, been at all recognised there. Its phenomena are perhaps covered by the term atomicity, but so much the worse, for that term is used for two orders of phenomena which are entirely different. If its use were restricted to signify the number of points or regions on an atom which are suitable for the attachment of others, it would have a definite meaning, and would express a scientific function of the form of the atom or molecule considered. But it is also used to signify states or aptitudes for union which arise from the previous history of the atom or

molecule. And many of those most interesting experiments of the laboratory, consisting in substitutions to a great extent without change or destruction of the type, are due to redintegration, attempts to restore or to fill with some kind of matter at least a mould or memorial of the primal structure which, during a state of deprivation, appears to survive in some ethereal form or mode of action. Thus, in order to saturation in the laboratory, silicium takes two atoms of oxygen and aluminium three, not because their atomic forms dictate these numbers respectively, but because during the genesis of silica and alumina in the crust of the earth and the course of nature these were the numbers of atoms of oxygen which fell to their respective lots. And in the laboratory the cosmical law of assimilation called for the redintegration of the primal species or some substitutionary structure to similate it.

28. As to form: sphericity, spherical cellularity.— A very cursory consideration of the cosmical law of assimilation is sufficient to show that, under it any individualised element, or any number of such elements, must tend to assume overhead a spherical form and to become a spherical cell or shell; for the spherical form surpasses all others in the amount of assimilation which exists among its parts or particles. Thus all the points in it are assimilated in their relation to one and the same point, namely, the centre. They are also assimilated in position in their relation to one another as far as is possible in any form that encloses space. The cosmical law, therefore, leads us to expect in nature the construction of spheres and spherules, cells and cellules, to the full extent that existing forces and material will permit. But there are many opposing forces and defects of material. Thus the construction of a sphere demands the incidence or excursion of a system of forces equally all round one and the same centre, which on the surface of

a planet that is kept in the concrete state by gravitation from below, and which is constantly borne upon by the sunbeam from above, is not easy to be obtained. It is therefore, generally speaking, on the surface of our planet, only among objects which are small and light, or whose specific gravity is nearly the same as that of the medium in which they are developed and which are secluded from the direct impact of the sunbeam, that the spherical in form is successfully reached. But in places where there are no such hindrances, there is no reason why the forms of the individualised objects existing there should not be as spherical as their counteractive motions will permit. Accordingly, looking to nature with the aid of the microscope and the telescope, which the too great nearness or too great distance of the fields of view render indispensable, it is found that the objects in both fields are little else but spherules and spheres on all hands. Indeed it would appear that the whole concrete, and still more the whole liquid and aeriform worlds, whether molecular or massive, consist of spherules and cells which previously to alteration were spherical.

As to the external and cleavage forms of crystals, they seem, at first sight, an exception to this general statement. They are angular; and of these angular forms only a part are monometric, or such that a sphere may circumscribe them. But this, as will appear hereafter, is only a seeming opposition to the general law of sphericity. It arises from the defective structure of their integrant molecules, which being themselves incapable of sphericity, are unfit for the purposes of life and motion, being residuary and angular. Meantime the nisus at the spherical in crystals, though they are incapable of attaining it, explains what has never been explained hitherto, namely, their marvellously multiplied bevelments and truncations, all which are plainly

improvements of form in relation to a spherical form as the type, which, however, cannot be reached by crystals.

Thus the cosmical law verifies the soundness of the ancient opinion in favour of the sphere as the most perfect form, and the circle as the corresponding figure. Thus it is the most perfect form ideally in so far as mathematics are true expressions of the properties of portions of space, its perfection being indicated by the comparative simplicity of its equation. Mechanically considered, also, the same character of its superiority to all other forms appears. Thus the sphere is equal arch all over and everywhere, and therefore to destructive forces incident in any one, or in all directions, it is the strongest to resist destruction. Moreover, its interior or capacity also as compared with the extent of its exposed surface, is a maximum. It is therefore the best of all forms for a vessel destined to contain precious material; as also for secluding that material from unfriendly external agencies. It is the best form for hibernating organisms, germs, cells, spores, ova, &c. The filled or solid sphere also secures the development of its contents when the conditions of existence permit; for every departure from the spherical in form must imply an extension of dimensions in the matter constituting the spherical solid. The sphere is therefore of all forms the best suited for holding, conserving, and developing an element of such a precious thing as living substance. And that the cosmical law should culminate in its construction is a verification of our theory that life and its wellbeing (which is enjoyment) is the end and aim of creation.

And here it may be remarked, in passing, that our theory calls for a change of terms in one of the leading conceptions of the theory of evolution as generally entertained. Instead of a tendency to a general or aimless variation in organisms, which is the ordinary conception, our theory implies a tendency to radiation or radiant

evolution from a centre or centres, an axis or axes, in a form which is ever aiming at its improvement, though succeeding but slowly, partly in consequence of the limitations imposed by the law of heredity, partly by the reaction from within of its own structure, and partly from the reaction from without of its environments.

29. As to symmetry: it results where sphericity is prevented.—Except in the case of a simple monad or element of plasm, the sphere is very difficult to construct. Moreover, where it has been constructed of elements which are themselves also homogeneous or assimilated to each other and spherical, the structure having fulfilled the cosmical law is ready for the separate individuation or isolation of its constituent parts or particles, an issue which, though it is a step upwards in the economy of nature, implies the dissolution or explosion of the spherical group (see sect. 25). Thus the homogeneously constructed spherical cell cannot be permanent in nature. It cannot but be short-lived. Its change of form from the spherical is essential to its preservation in the concrete state. And upon the whole, structures assimilated to each other or composed of homogeneous elements cannot be stable. They must be ever living and ever dying; and a tissue composed of them must be maintained by a succession of particles under the cosmical law of assimilation.

But where the spherical can neither be constructed nor conserved, the cosmical law must none the less be ever working, and multitudes of forms must be forthcoming, which, while they fall short of the spherical, still show in their shapes, parts, or particles, which are assimilated to each other in their position, that is, placed so as to balance each other on opposite aspects of some point, or plane, or axis of the forms. But this is merely to affirm that the forms are never devoid of some kind of symmetry. And such, then, according to the views

here advanced, is the rationale of the symmetry which, in a greater or less degree, all the truly individualised objects in nature display. It is the result of a nisus at the spherical. No doubt symmetry is also that form or structure which is most statical when viewed mechanically as a case of the composition of equal and similar forces.

But a phenomenon, considered as a manifestation of a fact or process in the economy of nature, is not fully accounted for when it is solved as a problem in statics.

The question is, What is the structure of the forces, and whence do the forces come, which render such a branch of science as statics possible?

The science of mechanics is good as a gymnastic in applied mathematics; but it does not either reach or teach the grounds of the science of nature. The greatest mathematicians have sometimes gone the farthest in framing and in maintaining the most irrational and even ridiculous hypotheses.

The precision of mathematical thinking exerted such a charm even upon such a mind as that of Newton as to induce him to countenance the theory of emanation of light, which was nothing less than the conception that light was produced by the emission from luminous bodies of certain particles which darted through space, and continued darting for many years in straight lines with a uniform velocity at a rate of nearly 200,000 miles in a second of time! And in our day a hypothesis has been conceived as to the constitution of aeriform media which looks too like the spawn of the theory of emanation, and is no less extravagant. But it has a charm of admitting of a mathematical discussion.

CHAPTER VII.

THE UNIVERSAL ETHER.

The cosmical law in assimilating the created substance as far as the finite can be assimilated to the infinite in respect of the Creator's immensity or omnipresence, distributes it in space as far and wide as possible, thus constituting the universal ether. The elements of which the ether consists, then, must be the *minima naturæ*, and each of them next to nothing both in being and energy. It is not easy to deduce the structure of the medium in detail, so subtle it must be in all respects compared with any material medium with which we are acquainted; but, happily, details are not necessary for our present purpose. It is, however, desirable to notice a few points, especially as these are calculated to relieve this medium, the medium of light, of some of the anomalies or seeming contradictions which popular conceptions and the existing state of physical optics assign to it. We may remark, then,

30. As to form, when in a state of repose, the ethereal elements are spherules identical with each other except as to their position in space.—From what has been advanced in the sixth chapter, this conclusion follows. And although one is tempted when reflecting on the extreme minuteness of the ethereal elements to infer that their sphericity consists merely in their being solid

centres of ethereal force without any vacuole in the interior, yet since forms are possessed of all their properties, independently of magnitude or minutencss, it is safest to regard the ethereal elements as fulfilling the cosmical law like larger structures in this respect, and to infer that the source or centre of force in each ethereal element is a shell or ccll or hollow sphere—how infinitesimally minute it is vain and unprofitable to waste time and thought in attempting to conjecture. It is more important to remark that a state of universal repose, such a state of thc medium as is here conceived, never actually exists. It implies universally the zero, both as to light and heat, and what not—a drcadful conception which need not be considered.

31. Urged in one linear direction (or in two such directions exactly equal and opposite) the ethereal element being pure plasm, will change its shape from spherical to annular.—If the ethereal clement had been a hard body, as it is usually conceived to be, it would, of course, if urged by a linear force in one dircction, change its place (not its shape), and procecd in that direction till it was stopped by the reaction of its environments. But bcing not at all hard, but, on the contrary, purely plastic, it will embody the disturbance imposed upon it by a change of form expressive of that disturbance. And such a change of form dcveloping under the cosmical law, is a change from a sphere to an oblate spheroid, the limit bcing an annulus, its axis in the direction of the incidcnt force, itself at right angles to it.

32. The return change of form will be the counterpart of this, passing through spherical towards prolate spheroidal, its limit spicular.—As soon as the primary agitation has expressed itself in dcveloping its appropriate change of form, the cosmical law will recall that form back to thc sphcrical. But its particlcs being actuated by incrtia, thcy will encountcr cach other

when they have reached the centre, and now they will develop an axial form, a prolate spheroid, in its limit a spindle or spicula, equivalent in the length of its axis to the dimensions of the annulus generating it.

33. Hence from radiant ethereal action, three classes of phenomena are to be expected.—*The first*, which models the ethereal element into an annulus (a form which the iris in the organ of vision may be regarded as representing), must be propagated at right angles to the direction of the ray. Now this, the mode of radiation which is *luminiferous*, has been found to be. *The second*, which models the same element immediately after into a spicula, suggests the *calorific;* while the *third*, occurring between these two, and twice as often as either (the same element becoming spherical twice), must, under the cosmical law, tend to assimilate the matter on which the incident ray is falling, into or towards the construction of spherical molecules—that is, it must manifest *a normal chemical agency.* But here there opens on us a field of inquiry on which we are not as yet prepared to enter, and must leave to others. We only make suggestions on the subject.

It may perhaps be thought that the structure and action here assigned to the ether is more like that of a living organised tissue, or at any rate more like that of a crystallised medium than that of a compressed aeriform such as common air, with which the ether is more usually compared; and that is true. But whatever the analogies between sound in compressed air and light in the ether, the attempt to regard sound and light as phenomena resulting in similar media by a similar undulatory mechanism raises more difficulties than it satisfies, and is, besides, based on an incredible supposition. How could the universal ether exist for ever in a state of identical and extreme compression all through the universe as the regular and uniform pro-

pagation of light requires? Nay, how could it come to exist in a state of compression at all? But if it be uncompressed, and each ethereal element occupies its full volume, motion cannot be propagated in it as it is in compressed air, where sound-waves are possible. The ethereal elements may indeed be steadied in their relative positions, so that the whole may form a lace-work or tissue, or an ethereal crystalline medium. But in this case the propagation of radiant action in it can only be very rudely compared to that of sound. That there will be a resemblance in the phenomena is certain, because there is but one cosmical law which determines all phenomena. And phenomena of motion taking place in conditions which are similar in any degree are similar to the same degree. But it is time now to give up the undulatory theory of light when referred to that of sound as the type.

Instead of large gross waves, it is time to ask what is meant by the constantly recurring term electricity, and to decide whether those physicists are not in the right who compare the streaming of light with that of electricity rather than of sound. If this is successfully done, it will at any rate relieve physics of a great embarrassment considered as a rational study. In that case the hypothesis of an indiscriminate and objectless radiation equally into all space falls to the ground. In that case there is no such thing as an enormous waste of energy every hour since the beginning of time, as most physicists are content to admit, but only giving, receiving, and making return, conservation of energy, action and reaction equal and opposite, throughout the whole universe, as we see on the small scale around ourselves.

CHAPTER VIII.

MATTER AND THE MATERIAL ELEMENT.

34. Matter or body is molecular and multiple, mind or spirit is monadic.—In the nisus of the cosmic plasm or "mind-stuff," when partitioned into ether to escape from the state of extreme attenuation and corresponding defect of energy in the individualities of which it consists, implying in them the absence of feeling and want of a capacity for enjoyment, and leaving in them only a residuum of dynamical force, matter and the material system make their appearance. This consists in a marvellously beautiful system of molecules, with changes of form and structure as their function, instead of a system of monads, with perception, feeling, and volition as their function, which latter demand unity as well as energy in the object which manifests them, a condition of existence which molecules have not and only monads have. Here, then, is one elementary difference between mind and matter, though there may be but one sort of "mind-stuff" to constitute both. The smallest portion of matter is a multiplicity, a molecule or molecular aggregate of elements, each of which is most feeble, so as to have nothing to spare to the others, whence the aggregate manifests no modes of energy not found in the constituents. The monad, on the contrary, is a unity. All the elements of energy which enter into it conspire

together and concur in the same direction. And thus, step after step of newly added energy, the modes in which the energy shall manifest itself becomes exalted, and by-and-by, when the quantity of energy belonging to the monad has attained a certain amount, the original, the mental modes of energy will make their appearance.

35. Matter is inadequate to produce the phenomena of mind.—It is a favourite hypothesis at present, and one which excites alarm in the thoughtful, involving as it does the belief that at his bodily dissolution a human being ceases altogether to be. This is a melancholy view which, while it is claimed as one of the inductions of science, is apprehended to have the most injurious bearings on philosophy and ethics. It affirms that molecules, when aggregated into a certain configuration (the myo-cerebral system), acquire new powers which they have not separately or otherwise; that, in fact, this material organism in its own right as a material tissue, has become capable of perceiving, thinking, feeling, willing, and, in a word, manifesting all known mental phenomena. The belief in a mental principle coexisting and co-ordinated with the organism is thus superseded. Mental phenomena of every kind are regarded as simply the functioning of the organism, ceasing altogether and for ever, when the organism ceases to function.

In illustration of this view, those who advocate it class the brain with the liver, the kidneys, &c.—each, it is said, having its specific function and terminating in it. But plainly this illustration goes against the hypothesis to support which it is adduced. The normal function of these glands is the birth of a peculiar substance—viz., bile, &c. And to make the illustration good, the function of the brain ought to be the birth of a peculiar substance, not necessarily of a material and molecular nature, but yet something possessing reality

and individuality, and possibly capable of existence elsewhere and otherwise than in the brain, as bile, &c., may do elsewhere than in the liver. The hypothesis at present so popular does not stand on a logical or scientific basis. No scientific analysis of any organism can find more in it or get more out of it than forms and movements with their changes. To these an addition even of force as their cause, is a hypothesis not given by the organism, but inferred by the observer from what he finds in his own consciousness; for it is from this source alone, in consequence of the character of volition, that the idea of force is derived. All that the materialist finds in the organism, and all that he admits, is machinery; and how machinery is to see, to feel, and to will, and how perception, feeling, and volition could make for the first time in the universe their apparition as the products of machinery, is surely quite incomprehensible and in the highest degree improbable. How could an aggregate of atoms, themselves admitted to be all blind and wholly apathetic, merely by being arranged as a tissue without any true unification or exaltation of energy in the individual, acquire sight and sensibility? A chain is capable of fewer functions than its several members when free. A gang of prisoners when chained together is not capable of the same amount of action as the same number of the same men if they were free. And besides evidence of this kind, who can say that it is a scientific step to connect matter and motion with perception, feeling, and volition as cause and effect? There may be a co-ordination and parallelism in the two classes of phenomena, which indeed the universal homology of creation leads us to expect. But to identify them, or to say that the one is the sole cause and substratum of the other, is not to reason, for the two things are manifestly disparate, but to escape from reasoning merely to indulge the mind in its often unwarrantable

love of simplicity, having no sanction but a merely subjective law of parsimony.

36. The place in nature of a molecular system.—But it may be asked why matter and a molecular system, and not monads and spirits at once as an immediate and direct return of the created substance (after it had been partitioned) to the Creator who is Himself a spirit, and whose omnipotence and universal imminence in creation might thus be expected, under the cosmical law (assimilation), to give birth to spirits at once and spirits only? Let it be granted that the material universe is a truly beautiful cloud-work in the azure of the world of spirits. Let it be granted that it is (as will soon appear) enlisted in the grand design of creation, the extension of enjoyment, becoming as it does even in this small and weak world of ours, the mother and nurse of spirits innumerable, yet why not such beings, beings capable of enjoyment, not merely at and near the fountain-head of creation, but all through and from first to last?

Accepting as the true grounds of creation those which have been assigned in this work, this question is not unreasonable. To find the answer, we must call to mind what has indeed been oftener than once laid down already—namely, that among the many bearings of the cosmical law it tells in reference to time as well as space. It assimilates to the past, the present, and the future, not absolutely, indeed, but under those limitations under which heredity acts; for the law of heredity, which has of late justly claimed so much attention from biologists, is merely this historical or memorial operation of the cosmical law. In short, the cosmical law is within limits an individuality-preserving, species-preserving power. Hence the ethereal elements, though they be in every respect the *minima naturæ*, still have a certain amount of power to maintain their individuality, and to be in the future as they have been in the past.

But they cannot altogether refuse to obey that action of the cosmical law which calls for unification. Hence they come together. But in these first groupings they come together by juxtaposition only, not by fusion. In a word, they form, not indeed as yet, a material molecule, only an ethereal molecule, which, conceived as in the celestial spaces, and more or less luminiferous, we may for shortness call a nebular speck.

37. The material element: its structure under the cosmical law.—As the primal molecule of ether, the nebular speck grows and consists of a greater number of ethereal elements, the tendency of all of them to be assimilated as to a position in space must constitute a pressure towards the centre of the group. And plainly, when a certain though undiscoverable number shall have concurred in exerting this centrad pressure, those ethereal elements which are most central, having no longer an individuality-preserving force sufficient to resist the pressure, will yield to it and fulfil the cosmical law as to its unifying clause more completely than they have done hitherto by becoming confluent into one, and thus constituting a monad of a certain power in the centre of an ethereal atmosphere. This new order of being or thing constitutes the material element in that view of the nature of things which is here most shortly stated.

And here certain features important for our future progress present themselves. Thus, since all ethereal elements are identical except as to their position in space, the same must hold good in reference to material elements, at least as to the quantity of ether conserved in their genesis and attaching to them, when none of it has been abstracted, crushed out, or vaporised away. Moreover, each material element being a differentiated structure, consisting as it does of a molecular atmosphere and a monadic nucleus, does not fulfil the cosmical law which calls for assimilation all through, and therefore

for homogeneity of structure. As not having fulfilled the cosmical law therefore, and as having that yet to do, the material element is secure against partitionment and the individuation of its ethereal particles either by deliberate solution or by explosion (sect. 25). It is in short a very permanent thing. Not but the paramount assimilative influence of the universal ether in which it exists may secularly dissolve and resolve into ether again each material element after it has existed for a certain epoch. But as fast as aged elements vanish new ones will be generated; for the analytical and synthetical operations of the cosmical law are co-ordinate and equal. And thus, though vitally as it were and cyclically as everywhere in creation, the permanence or "persistence" of matter and force will be maintained, at least within such limits as no mere physics can reach either to affirm or to contradict.

38. An alternative in its structure.—On arranging a number of equal and similar spherules in harmony with the cosmical law—that is, in such a way that the group shall be cellular as well as spherical—it becomes a question whether the wall of the central vacuole shall be built up of twelve or of twenty ethereal elements, the former group being that which, as a geometrical conception, gives the dodecahedron, the latter the icosahedron, two of the Platonic polyhedra which are so beautifully related that each circumscribes and inscribes the other or tends to generate it. Considering the importance of a differentiation of structure as a means of imparting stability to any structure, and the exquisitely harmonious relation of these two polyhedra to one another, we are led to conclude that the unified nucleus of the material element will consist of both—that is, of $12 + 20 = 32$ ethereal elements dovetailed into each other. But still the inquiry remains, Which of the two, twelve or twenty, shall be innermost? To this no

solution can be found by a reference to what is known in physical science. Electricity, as "induction," that mode of action by which one state or current tends to develop a state or current which is consecutive, and both, such that they tend to exalt one another, and when they normally concur to produce repose and a better state, explains many things. The phenomenon is included among the modes of differentiation, and it has no new light for us here. Let us, then, only state in connection with our present subject that, supposing one material element to be generated with twelve material elements centrad in its nucleus and twenty overlying them, this would tend by induction to bring it about that the next course of elements generated in juxtaposition should have its twenty centrad, its twelve overlying. And thus eventually there would be about equal numbers of material elements internally differentiated, not as to quantity or as to specific character, yet so that, as dissimilars (under the well-known law of chemistry), they would tend to unite in couples, thus providing so far at least for the union of material elements.

39. Sex ?—As soon as we enter on the details of molecular synthesis, it will appear that this mode of union by coupling or conjugation is the very characteristic of that synthesis and the key to molecular construction and chemistry. But does it terminate in the purely chemical sphere, and is it not manifested at all in animals and plants? Nay, does it not prelude and prepare the mind for the discovery and existence of sex? Viewed as a free institution, one for which there was no necessity nor reason in the nature of things, the apparently universal existence of sex, more or less developed in every organism, an institution by which half of the individuals in the highest species are rendered incapable of continuing the species if left without the presence and concurrence of others of the same

species, seems a very strange and unaccountable feature in the economy of nature. But the difficulty disappears at once if it be that in the structure of the atom itself there exists an alternative structure such as might be expected in organisms to manifest itself in constituting a difference of sex. If it be said that this is surely going too far, generalising beyond measure, the same fault may be found with every paragraph of this work. The law of heredity, for instance, is here claimed to be coextensive with the sphere of chemical as well as bioplasmic action; and it is, in fact, maintained that a homology pervades the whole creation, the whole being the consequence of only one cosmic law and of only one Creator.

CHAPTER IX.

THE FIRST AND THE LAST ELEMENTAL STRUCTURES IN THE MOLECULAR SYSTEM OF NATURE — THE TETRAD AND HYDROGEN.

40. Molecular synthesis and analysis is normally a process of doubling and dedoubling under the cosmical law.—Under the tendency to be assimilated as to the place they occupy, the material like the ethereal elements tend to come together and to form molecules—the term molecule being here, and throughout these pages generally, used for any structure composed of two or of any number of material elements, whether that structure be decomposable by the chemist or so stable as to have hitherto defied his attempts to decompose it. It includes the "atoms" or elements of chemistry as well as its molecules.

The number of molecules which may be constructed and continue individually in existence for a considerable time in the earth, sun, moon, and stars, must be all but infinite. In our own planet they are very numerous. But in whatever region of the universe, if the conditions of existence be highly unfavourable to molecular synthesis—as, for instance, extreme heat, or vastitude of space as compared with the quantity of matter in it—they are but few. In fact, the alternative structure in the nucleus of the material element stated in the last chapter (sect. 38), together with the operation of the cosmical law, brings it to pass that the first and the last members

of the molecular system shall be only two, and in this planet at least, all the intermediate structures, products of these two! Possibly in other spheres where gravitation and heat are very different from what these agencies are here, other modes of molecular synthesis may prevail. But by all that appears as yet, the earliest and the latest elements of the molecular system which are in harmony with the cosmical law are universally the same. Of these, the first has not, however, as its nucleus a pair of material elements coupled in juxtaposition more or less with their two ethereal atmospheres confluent on the peripheral regions, as might have been hastily expected. Such a structure does not accord with the cosmical law. That law calls for sphericity of form; while a single couple when united, their nuclei still distinct, cannot but form an ellipsoid, whence, if they be not succoured by other couples, the cosmical law will sooner or later separate them again into two free atoms.

41. The Tetrad.—But when one such couple meets with another similar couple, and the two couple again crosswise or symmetrically, there results the nucleus of a molecule, the four centres of force of which it consists forming the angles of an elemental tetrahedron. This nucleus is therefore the first of the regular polyhedra and as spherical as possible, while the peripheral region consisting of the four confluent ethereal atmospheres of the four constituent atoms may be perfectly spherical.

The Tetrad.[1]

[1] The white diagram means the nucleus poised as a trigonal pyramid. The four white points, the positions of the centres of the four constituent elements. The white lines joining them, the last resultants of the powers which keep them *in equilibrio*. The black circle, the near portion of the ethereal atmosphere, which, however, should have been shaded.

Here, then, is a molecular structure eminently in harmony with the law of sphericity, presenting as it does in its central and its peripheral parts the two extremes of that whole series of forms and structures which can be in perfect harmony with the cosmical law, of which the most eminent geometrical members are the Platonic polyhedra, to which is to be added the sphere itself as the monometric polyhedron with an infinite number of faces.

And here the reader may be already impatient to ask, If our molecular system represents that of nature, what known substance does this tetrad represent? To this the answer is, that possibly far out in space, where matter exists in utmost rarity, there may be a homogeneous medium composed wholly of tetradic molecules. But the tetrad or elemental tetrahedron, as the crystallographer has long ago discovered, is a hemiform, and it may be shown that it must either be its own universe or be essentially parasitic. Unless it be wholly beyond the influence of other matter, and its calorific action have its centre for the centre of symmetry of the form which it actuates, that form will by that action be driven hither or thither until it clap down on some other molecule by some one or other of its four bases. Possibly, therefore, in very high and rare regions—as, for instance, high above the solar atmosphere—a medium composed of such rare molecules may exist, and thus certain unknown coloured light indicated by the spectroscope may be accounted for by it. But if in the same region there should be a single material element along with the tetrad, a new molecule may be expected.

42. Hydrogen.—Given a single material element in the neighbourhood of a tetrad, being dissimilar, the two will (in accordance with the prevailing law of chemical action) unite. And the mode of union which the cos-

mical law suggests is that the single material element, or, let us say at once, the single atom, shall place itself opposite the centre of one of the four bases of the tetrad, poised at the same distance as the atom on the other side which enters into the structure of the tetrad. Now, by this accession the tetrad or trigonal pyramid, a hemiform all angles and bases, is transformed into a crystalline or easily insulable form—a bipyramid, the simplest possible in structure, consisting of two similar poles, each constituted by a single atom (the smallest number which can determine an axis), and an equator evenly balanced between them, consisting of three atoms (the smallest number which can determine a plane). (See fig. H.) Its atomic weight is $4 + 1 = 5$. The form of its ethereal atmosphere at the zero of temperature is a slightly prolate spheroid. And so rich and manifold are its modifications of form and its modes of action that a volume would be required to indicate them all. Suffice it here to say as to form, that it is eminently dimorphous. It may exist, as here represented, with an axis and similar poles as well as an equator, a structure perfectly well suited for individualised, free, or aeriform existence. Or it may exist as a form, consisting merely of five atoms in the same plane equidistant from one another and from their common centre. And this latter form we may regard as its coronal, parasitic, or occluded state. And in this case its form overhead (the form of its ethereal atmosphere) is an intensely oblate or negative spheroid, or, it may be, sometimes an annular or life-buoy form.

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The Nucleus of Hydrogen.

43. The tetratom of hydrogen.—In order to the genesis of an atom of hydrogen according to the pre-

ceding view, there must be in the region of genesis and in each other's neighbourhood not only tetrads, but also single elements of matter or atoms. But hydrogen may be generated in a medium which consists of tetrads only. Thus, let five tetrads aggregate themselves in such a way that the group shall be at once most spherical and most fully expanded or cellular—that is, let there be a central tetrad with four others around it, each with a facet or base fronting the four angles of the central tetrad, and poised at the same distance as the atom or angle on the other side of that base; we have then a molecular structure which is eminently in harmony with the cosmical law. Its atomic weight is $5 \times 4 = 20$, and, just according to our object in looking at it, it may be designated a group of five tetrads or of four atoms of hydrogen—$4 \times 5 = 20$. In the tetradic arrangement, resulting from its mode of genesis, it is difficult to represent in a diagram. But when adjusted in harmony with incident forces—that is, when one of the four atoms of hydrogen stands as an axis and the other three as equatorial arms, at right angles to the axial atom—the accompanying diagram of a tetratom of hydrogen may give some idea of it.

The Tetratom of Hydrogen.

The Hexatom.

44. The hexatom of hydrogen.—The tetratom viewed overhead or in its ethereal atmosphere is, however, obviously oblate. To fulfil the cosmical law, by being spherical, it is in want of something on each pole. If,

then, hydrogen be the only substance in the neighbourhood, an atom of H will attaeh itself to eaeh pole of H_4. And there will be generated a hexatom of hydrogen. (See the diagram.)

45. The hexatom differentiated by the poles.—But this hexatom is simply the reproduetion of the single atom on a large seale. In aiming at the spherieal, therefore, the tetratom of H in beeoming the hexatom has overstepped the spherieal, for the single atom of H is, as has been stated, prolate. And besides, this hexatom is a homogeneous strueture, whereas a eondition of permanenee in moleeular struetures is differentiation. Let some element, then, be found whieh is at onee different from H and has a shorter axis, and let two atoms of this new substanee substitute the two atoms of H on the poles of the hexatom of H, and then there will be a strueture possessing in an eminent degree the eonditions of stability, and whieh we may eonfidently look for in nature. (See the diagram named "Marsh-gas.") It is of eourse impossible at this stage of our moleeular synthesis to show how the two differentiating elements on the poles have been obtained, or how felieitously they represent two atoms of carbon, which, however, as they are usually required by the law of symmetry to go and eome and move in eouples, have of late unhappily been taken for one atom only.

Marsh-gas.

But already, although as yet we have reaehed a strueture to represent hydrogen only, many phenomena of the laboratory explain themselves, whieh otherwise and hitherto have seemed quite arbitrary or unaeeountable. The following may be glaneed at.

Since the atoms of carbon, as may be seen in the diagram of marsh-gas, are oblate or short of sphericity, they will (as atoms in general tend to do on other grounds) tend to couple on the poles of that atom. Now this gives C_4H_4 (Cahours) an atom of olefiant gas, an aeriform which for a long time was confounded with marsh-gas.

If, again, instead of merely a naked second atom of carbon on each pole of the atom of marsh gas there be added an atom of CHO (of which the dodecatom $C_{12}H_{12}O_{12}$ is a sugar) there results an element of alcohol $C_4H_6O_2$ (Cahours).

And if, instead of CHO there be added CO_2, that is, an atom of carbonic acid on each pole, then there results an atom of acetic acid $C_4H_4O_4$.

And if, instead of CO there be added the equivalent N, there results an atom of urea $C_2H_4N_2O_2$.

Some conception of the structure of these substances which play such an important part both in nature and art, may be formed by writing them as under, a couple or two atoms of carbon or of oxygen being indicated by a black-faced letter.

	Pole.	Body.	Chem. formula, C = 6, O = 8.
Marsh gas .	C	H⁴	C = C_2H_4
Olefiant gas .	**C**		**C** = C_4H_4
Alcohol . .	HO**C**		**C**OH = $C_4H_6O_2$
Acetic acid .	**OC**		**CO** = $C_4H_4O_4$
Urea . .	NC		CN = $C_2H_4N_2O_2$

46. The hexatom differentiated on the equator also.—It is still more in reference to substances which are products of the substitution of atoms of hydrogen by some other element on the equators of the hydrogen molecule that the value of our theory of hydrogen appears as giving great insight into many molecular structures, entitling, justly, chemical formulæ to the name of rational.

Thus the sight of a tetratom of hydrogen (p. 52) shows that the three equatorial hydrogens (in marsh-gas,

for instance) may be easily detached and carried off, their places under the law of redintegration being filled up by something else; while the axial atom, on the contrary, is so secured, that notwithstanding this substitution of the equatorial arms, the type of the molecule shall remain unchanged. Thus let a halogen, as, for instance, chlorine, be presented to marsh gas in the requisite conditions at once of change and of regulated action, and it may be expected that the equatorial structure $H_4 = HH_3$ will be changed into HCl_3. Preserving the poles as before, we thus obtain—

$$CHCl_3C = C_2HCl_3 = \text{Chloroform.}$$

And similarly, when the poles are further loaded, as they are in alcohol and acetic acid, or otherwise, we obtain a host of "trichlors," of which chloral and its hydrate may be mentioned as of no less interest and value than chloroform.

But these substances, most precious as they are for quenching all organic feelings, when the state or action or treatment of the organism would otherwise impose suffering, are but products of art, and are but few and small compared with those products of nature in which the three equatorial arms of an axial tetratom of hydrogen are substituted by another substance. This substance, however, is not a halogen, but simply carbon itself. And it is constructed in the organic, specially the vegetable kingdom during the autumnal period of life, when both oxygen and hydrogen have been eliminated to the utmost. Not but such a structure may be also expected among the ultimate products of the animal kingdom also. And in point of fact so it does occur there, developing uric acid instead of urea, &c.

$$\text{Urea } C_2HH_3N_2O_2 \text{ becomes } C_2HC_3N_2O_2 = C_5HN_2O_2 \begin{cases} \text{Uric acid.} \\ \text{Monobasic.} \\ \text{Anhydrous.} \end{cases}$$

But, unhappily, methane (marsh-gas) when the three equatorial hydrogens are substituted by three carbons, is so loaded with fixed matter that it cannot be raised into the aeriform state, so that it has often to be passed in the laboratory merely as a carbonaceous residuum containing some hydrogen.

When duly aggregated in its appropriate molecule, however, this element, $C_2HC_3 = C_5H$, and when its poles are mailed in oxygen and thus the molecule protected from that almost universal disturber in the terraqueous globe, it assists in constituting all the most interesting alkaloids and the most beautiful colorifics.

47. The hexatom preserved but differentiated less or more or altogether.—When the poles of the hexatom carry matter of sufficient weight and affinity to hydrogen, the hexatom of hydrogen retains its integrity. Thus given for a polar element an atom of phosphorus or of arsenic or other suitable substance, and there are obtained gases or other isolable structures containing not four but six atoms of hydrogen. In consequence of an unaccountable disregard of the law of symmetry, which all nature proclaims aloud, and which demands two poles and an equatorial region in every individualised structure, chemists, for the sake of the lowest possible numerals in their formulæ, commonly set down polar elements as one only instead of two, so that these formulæ require to be doubled in order to represent the entire structure of the substance in hand. And thus we have—

	Chem. formulæ.	Entire structure.
Phosphuretted hydrogen	PH_3	$PH_6P = P_2H_6$
Arsenicated hydrogen	AsH_3	$AsH_6As = As_2H_6$
&c.	&c.	&c.

Here also those ammonias which have stability sufficient to survive the ordeal of the laboratory find their place. But the nitrogen of chemistry, including as it does both

the zote, the antizote, the azote, and the bizote of our molecular system, forbids our touching on ammonia in this place. And with one remark more we will leave for the present hydrogen behind us.

48. Hydro-carbons of the more perfect type of marsh-gas, when broken down assume a linear type, functioning like simple hydrogen—viz., methyl, ethyl, acetyl, &c.—Referring to the diagram of marsh-gas (p. 53) it will be seen at once that four atoms of hydrogen are necessary to construct it. If one of them be anyhow withdrawn, the residue can conform to the law of symmetry only by the transference from the equator to the poles of the two atoms remaining. And such moniliform structures may be extended till they consist of a considerable number of alternate atoms of hydrogen and carbon without violating the law of sphericity too much, because the length of the axis of the atom of hydrogen depends to a great extent on its situation.

And here it may be stated that a good deal may be done for constructing diagrams of molecules by the use of types which are already in the hands of the printer—a method which, of course, saves much trouble and expense. Thus, as hydrogen is a prolate axial simple structure, let us take as its symbol its conventional atomic weight, figure 1. And as carbon is an oblate form, let us take as its symbol a cipher with its long axis horizontal. We may thus give diagrams of the simpler members of the series—methyl, ethyl, acetyl, &c.

Methyl	1 o 1 o 1	1 o 1 o 1 o 1 o 1	Ethyl
	C_2H_3	C_4H_5	

Now, as to the functioning of such hydro-carbons,

since their equators, as also both their poles, are hydrogens, keeping in mind that these are the regions of molecular functioning in general, it will be at once perceived that, however numerous their elements, they will function merely as extended atoms of hydrogen, but with this difference in favour of experimental chemistry, that, being loaded by carbon, they will be less volatile and mobile, and capable of enduring without the decomposition of the molecular structures into which they enter, the ordeals of the laboratory. Hence, by the ingenuity of chemists there has already been obtained a multitude of molecular structures in which the body consists of a hexatom of hydro-carbons of this type, while the poles are those of the ammonias, simple or capped with other elements, and which, therefore, function as alkalis, or otherwise, according to the structure of the poles. Of these, the simplest are the methylamines, which, indeed, have been met with elsewhere than in the laboratory. Doubling the usual chemical formula to give the molecule two nitrogen poles instead of one only, and arranging the symbols, as far as possible, in accordance with the law of symmetry, we obtain for—

Ammonia when most stable	$N\left\{\begin{matrix}H\\H_4\\H\end{matrix}\right\}N=2.N\left\{\begin{matrix}H\\H\\H\end{matrix}\right\}$	Product of the decomposition ammonia.	
Methylamine	$N\left\{\begin{matrix}C_2H_3\\H_4\\C_2H_3\end{matrix}\right\}N=2.N\left\{\begin{matrix}C_2H_3\\H\\H\end{matrix}\right\}$	The half molecule.	
Dimethylamine	$N\left\{\begin{matrix}H\\(C_2H_3)^4\\H\end{matrix}\right\}N=2.N\left\{\begin{matrix}C_2H_3\\C_2H_3\\H\end{matrix}\right\}$	Do.	do.
Trimethylamine	$N\left\{\begin{matrix}C_2H_3\\(C_2H_3)^4\\C_2H_3\end{matrix}\right\}N=2.N\left\{\begin{matrix}C_2H_3\\C_2H_3\\C_2H_3\end{matrix}\right\}$	Do.	do.

Experimental chemists have exercised themselves very much in trying how many of such molecular structures they can succeed in obtaining. Thus, as in hydrate of

ammonia, which consists of an atom with one of HO on each pole, so the dexterity of chemists has succeeded in further fixing a moniliform hydro-carbon, as also aqueous matter, on each pole of these compound ammonias. Nay, they have constructed such a hydrate as this—

Methyl-ethyl-propyl-amylammonia!

$$AZ \left\{ \begin{matrix} C_2H_3 \\ C_4H_5 \\ C_6H_7 \\ C_{10}H_{11} \end{matrix} \right\} OH \text{.....The half molecule.}$$

Their results, however, are of little scientific interest, as they are neither natural nor cosmical. Nature, in this planet, does not award existence to any of them, though some of the simplest may be obtained from natural substances by dry distillation, &c. And they are not cosmical, but proper to a small range of pressure and temperature only. Instead of spending years on the getting up of merely factitious substances (the Admirable Lawrent is said to have spent ten years of his precious and too short life in experimenting on the combination of naphthaline with chlorine and bromine, which, moreover, in consequence of his method not enabling him to detect the true structure of molecules, he sadly misinterpreted), would it not be far better to bestow more serious and logical thought (than that which is commonly bestowed nowadays) on such questions as whether there be really two or only one atom of hydrogen, as has been maintained till lately by the greatest chemists, in the least element of aqueous matter, or whether there be three or only two atoms of oxygen in the least element of silica? Can a method of molecular representation be equal to what it ventures upon, which cannot determine the structure of the most facile and abundant substances which nature gives to form both sea and land? What experimental chemistry has done is indeed

much to be admired, and the arts and consequently the amenities of life have reaped much advantage from it. But the scientific interpretation of experiments has not, of late, been so successful. Experimenters have ventured to determine molecules on too few and too obscure data, and without co-ordinating their thoughts with the analogy of nature and the principles of mechanics, which are, no doubt, regulative of molecules, as they are of masses. Practical chemists are very adverse to the theoretical attempt to discover the actual structure of molecules. The foremost of them all, indeed, has proposed, and carried out his proposal in his four-volume organic chemistry, to note the constituents of a molecule by the initial letter of their names set down in the formulæ in the order in which they occur in the A, B, C, &c.—the first literature of infancy. I think there is occasion to go back to the alphabet of thought upon this subject, but not in this way. The mental eye can see a structure much better than the mortal eye. It can see all that is within it as well as all that is outside of it, and can exercise its judgment upon it in every scientific aspect. In order to this, all that is needed is an adequate conception of the least separable particles of matter and the forces which actuate them or the movements which are normal to them. And why should such a construction be looked upon with despair in our day? It was not so regarded by men of science either in ancient times or at the revival of thought in modern Europe. And though it is usual nowadays to think and to speak very slightingly of the physicists of ancient Greece and of the chemists of early Europe, I do not think that their insight into the economy of nature is to be altogether undervalued in comparison with that of our day.

CHAPTER X.

ON ORGANIC LIFE—ITS ECONOMY AND ULTIMATE PRODUCT.

THERE are between sixty and seventy particles of matter which chemists, down to the present day, have not succeeded in decomposing, and which, strange to say, on this negative evidence they have concluded to differ from all the thousands of other particles which, in the progress of analytical chemistry, they have succeeded in decomposing, and hold to be simple and solid unities, or true natural atoms of matter. Surely it is most improbable that human creatures in this small planet should be able to accomplish in their chambers the destruction of particles on which the economy of nature out in the universe has mainly been devolved, and whose stability, before they come into the hands of the chemist at all, has been secured by the consolidating power of an abyssal pressure for innumerable ages, and tested by the dissociative ordeal of the central heat and the volcano when in the mass, and by the white heat of star and sunbeam when in the acriform state, as also by a state of rarity in which they are far from filling adequately the region in which they float.

49. The laboratory residua of living organisms: oxygen, hydrogen, nitrogen, carbon.—The atoms of the chemist are usually regarded as either inorganic or organic elements, of which, unhappily, the former are

usually discussed in detail in chemical works before the latter. About one-third of the entire number are indeed obtained, though most of them in small quantity only, from the analysis of dead matter which once had lived; but there are only four which are obtained in large quantities, and which appear to be essential to living tissue: these are hydrogen, oxygen, nitrogen, and carbon. Such are the eminent organic elements of chemistry. And this name, "organic," has been assigned to them, not from the discovery of any peculiar fitness in them, so far as I am aware, for constructing living tissue, but merely because when such tissue has been destroyed and decomposed to the utmost which chemical analysis can at present effect, these four substances emerge and display themselves as residua or last survivors in the chemist's destructive processes.

50. The least elements of living tissue are aqueous and ammoniacal vapours detained in the non-aeriform state by carbon.—From what we know of the habits of oxygen and hydrogen when coexisting in the same region in the non-aeriform state, we look for aqueous matter as the result. In this state, therefore, in the main, it is to be inferred that the large quantity of oxygen and hydrogen in every living organism exists. As to hydrogen and nitrogen, also, when in the same region and in the same non-aeriform or nascent state, there is good reason for concluding that they exist as ammonia. Thus, for three of the chemical organic elements considered as entering into living tissue, we obtain only two, aqueous and ammoniacal matter, of which it is impossible to speak more particularly here, because they are so easily transformable and so polymorphous.

As to carbon, when compared with these elements, whether viewed as the permanent gases of the laboratory, or the tenderly-constructed vapours of nature, it exists in most remarkable contrast. While they are

eminently mobile and volatile, carbon is eminently fixed. Nature does indeed possess the means of rendering carbon volatile too—namely, by uniting it either with oxygen or with hydrogen—and therefore of getting rid of it from the organism when it has served its purpose there. But plainly the state in which it is wanted for the construction of living tissue is the naked state. Thus, in union with oxygen gas it is given off into the atmosphere abundantly as fixed air wherever there is fire or animal life; but coming into contact with the vegetable clothing of our planet it is appropriated in the naked or half-naked state, and the oxygen is restored in a state of purity to the atmosphere.

Now this remarkable contrast in the functioning of carbon as compared with that of the vapours which along with it go to constitute living tissue, explains what organic life is, and its principal phenomena. It shows also that an organism is not an urn for ashes merely, but how it may be an eminently mobile synthetic apparatus, possibly well suited to be the mother and nurse of an order of beings adequate to manifest mental phenomena, of which the characteristic is unceasing activity and change.

51. Organic life is a state of intimate movement in the organism, more or less normal to it as such; and death is a cessation of that movement, and a lapse into mere molecular motions.—In order to organic life there must be a plastic-concrete, or at least a non-aeriform structure, and that structure, at least in its living parts, must be actuated by unceasing movement in its constituent particles, productive of unceasing change. And of that change during the first epoch (the flowing tide) of life, the characteristic is growth by the accession and assimilation of matter from without (food), under the cosmical law assimilating the growing form to its antecedents (heredity), modified on the one hand by the

cosmical law ever tending to develop the most perfect of forms (cellularity with spherical contour), and on the other hand, by the reaction of its own particles and of its environments, ever tending to establish mechanical stability issuing in degeneration of tissue.

Meantime, during the whole of this epoch of the flowing tide of life, while matter is coming in to add to the mass of the organism, the volatile elements constitutive of the organism, and carbon furnished with two wings by oxygen, are constantly going out, so that a living organism is continually the focus or locus at once of a radiant and entrant current.

But the cosmical law, as *heredity*, as soon as the ancestral structure has been fully developed, including certain particles not involved in the trammels of the individual, and though sometimes so minute as to be even invisible, yet under the cosmical law of assimilation assimilated so as to be mirrors of these ancestors—the cosmical law, as heredity, having been now fulfilled, further development ceases. The tide of life has flowed up to the full. And no reason appears why an organism, having reached this stage of maturity, provided the period of growth and development were slow, might not live very long if only the balance could be maintained between itself and its environments as to income and outflow.

But sooner or later the law of *assimilation*, having impressed the organism during all the period from the time when it was a single cell to its maturity, will begin to tell upon the fully developed structure, and, as a law of *redintegration*, call upon it to live its life over again backwards. Hence decay falling into a second childhood, and, ultimately, dissolution, into separate molecules or dust.

It is in these words, therefore, "in sorrow thou shalt bring forth *children*," that the sentence of death exists as science.

52. It is not organic life itself, but development under the law of heredity, that involves death and dissolution.—If an organism as perfect as possible were created *at once* in a state of full development and maturity, so that it should not be subject to the law of heredity, and if its environments were so adjusted as to supply all its needs in answer *at once* to its normal activities in relation to them—so perfect, as appears to me, is the molecular economy, that such an organism would, I think, be immortal. And consequently, there is nothing unscientific in the conception of immortality when applied to an organised frame viewed in itself.

53. Organic life, and the economy of molecular nature generally, is not development all in one direction, but is cyclical.—The cessation of the movements or currents proper to the organism as such, is usually regarded as the end of life or the death of the individual. But it has been seen that before this normally takes place, that organism has produced zopyra or living embers, capable, when the conditions of development are suitable, for continuing the life of the species. And thus the system is not a mere fall into death, but also a revival and restoration of life ; in a word, it is cyclical.

And this order of things does not hold good in reference to organisms only, it applies to the whole molecular economy, mineralogical as well as biological. Thus, with regard to silica itself, its molecular structure, as obtained by our method, shows that it is not destined to remain for ever dead, giving to nature nothing but barren rock and sand. Every atom of it is capable of development into coupled atoms of oxygen and carbon and a tetratom of hydrogen. This the actual chemistry must assent to, thus far at least, as to admit that their atomic weights are the same.

$$\text{Silica, at. weight } 60 = \left\{ \begin{array}{l} 2 \text{ Oxygen } 32 \\ 2 \text{ Carbon } 24 \\ 4 \text{ Hydrogen } 4 \end{array} \right\} = 60$$

With this view the recent doctrine advocated by a few physicists of a continual dissipation of energy, and universal death and darkness at last, is quite at variance. But that view is based upon mere suppositions or postulates, which neither have been nor possibly ever can be verified. And inasmuch as the nebular theory enters into the same view, the alleged finale is incompatible with it; for if there be heat enough at first to maintain the material universe in the state of a cosmic gas, and the doctrine of the conservation of energy be sound, then it follows that, after all the condensations and concretions effected by gravitation or otherwise, and all the heats and chills occurring during the life of nature, the last result must be a return to the first, a general aeriformation of matter and the nebular state; for that alone can have capacity for all the heat-energy that was in the system at first. Not development in one direction only, issuing in universal death and darkness, but life and death and revival, light and darkness and light again, cycle after cycle, is the economy of nature responsive to the breathing of the Creator who liveth for evermore.

54. The easily transformable and volatile elements of tissue (aqueous and ammoniacal matter) tend to keep up organic life, but that life tends to be quite ephemeral.—Aqueous matter generally, in all its non-crystallised states, and they are many, is known to be intensely "quick" and penetrative, and always bent on getting into the free aeriform state, or state of vapour. The same is no less, nay, still more true, of ammoniacal matter. Its functioning, indeed, when it has not been interfered with by the chemist so as to transform it, is curiously analogous to that of aqueous matter. Thus it enters into heavy molecules as aqueous matter does into light ones, as a *quasi* hydrating element. If, then, of these volatile elements alone (which, as laboratory residua,

are oxygen, hydrogen, and azote) an organism were composed, it could not in our planet, at least, at ordinary temperatures and pressures, remain long as a concrete or solid body. Its organic life would be very intense while it lasted, but it would be quite ephemeral.

55. The fixed and fixing character of carbon detains the volatile elements in the dense state and prolongs life.—It is very remarkable, and has hitherto remained wholly inexplicable, that so light an element as carbon when by itself should refuse as it does to rise into the aeriform state. Why it comes to do so will appear afterwards. Meantime we see why it is justly regarded as the special organic element. In virtue of its very fixed character, if it be suited for entering into union with aqueous and ammoniacal elements, it must be very valuable for fixing, bolting, or soldering them together, and for preventing them from going immediately off into the aeriform state, as they tend to be when left to themselves. Now the atom of carbon, as will be seen by the mind's eye when we reach its structure, is not spherical, and therefore is not a reposing or inactive element like azote, which is eminently spherical. Carbon tends to enter into union with other elements, both by its equator and its poles. And we shall find that when it enters into union with the organic vapours, so as to constitute living tissue and regulate their life, it unites with them equatorially. When, on the other hand, it has done its duty and is exhausted, and requires to be removed from the organism, it unites with the residua of the organic vapours (that is, with oxygen, hydrogen, and azote) by its poles, and along with oxygen at least becomes capable of the aeriform state, and of leaving the organism for the atmosphere as carbonic acid. In union with hydrogen, also, carbon becomes very mobile, and only remains in the organism long enough, normally, for the oxygen which circulates in

the body everywhere to resolve the hydro-carbon into aqueous matter, and carbonic acid as before.

It would not suit if the effcte carbon in union with azote were to escape into the atmosphere; such combinations are eminently poisonous and destructive of organic life. This carb-azotic combination is therefore conveyed away downwards, encased in abundant water (the normal percentage being the same as that of salt in the sea) and in such circumstances, that by the aid of the carbonic acid, which is always present in the same regions, ammonia is speedily regenerated, and food is supplied for the living parts of vegetable nature wherein animal nature is appointed to find its food.

As to the characteristics of those molecules which act as poisons and destroy organic life, it were premature to attempt to define them. This cannot be done until the ultimate structure of living tissue, especially the nerve-tissue, is known. It is obvious, however, that carbon, when in such a state of combination that it enters into the living organism otherwise than in food, is an eminently poisonous substance. It may then be truly said, and it is no paradox to say, that it is by the presence and operation of a slow poison in the organism that life is prolonged. Still, for the most vigorous organic life, plainly carbon should not accumulate in the body more than is needed. It should not be allowed to enter into the living and working tissue when its structure is complete, but as a reserve in some innoxious form, such as spherical and reposing molecules of fat or oil.

56. Hydro-carbons, fats, and oils: their place in nature, and their value.—When thus kept mobile, carbon may be very valuable to meet the demands of the tissue (which, in order to live, must be always undergoing transformation) during periods of respiratory or assimilative derangement. There is, moreover, good reason to believe that molecules which can be got rid of

by oxidation, and which, meantime, as spherical and stable, are, in virtue of their form, thus so far fulfilling the cosmical law of form, are valuable when generally diffused throughout the organism, in assisting molecular synthesis in the right direction by what has been called catalytic action. Spherical oil-molecules may also be valuable as dunnage and as friction wheels.

As to the normal course and place of fat in the system, it may be viewed as carbon moving from the living tissue, not by oxygen but by hydrogen, mobile, but not so volatile as to admit of escape like carbonic dioxide by expiration; yet, like the matter of expiration, bent on pursuing an outward course, when it is arrested by the skin-tissue and deposited in the cellular substance beneath, where, being lodged, besides being a store to support respiration when food or its assimilation is low, it forms a valuable protection of the blood and vital organs against external cold.

57. The growth and continued coherence of organisms, and all other non-aeriform bodies, depend, in great measure, on their differentiation.—No fact is more familiar in molecular science than that the condition of union, and of continuing thereafter united, is a difference in the parts or particles in relation.

When the difference vanishes on union being accomplished, as in electrical phenomena, the parts or particles forthwith separate again. But when the difference continues, as in cases of chemical union, they remain united.

The differences, either in internal structure, surface, or external form, are infinite. Of surface, the most remarkable differences are metallic and non-metallic; and of form they are positive or negative—that is, prolate or oblate spheroidal. Under one or other of these two forms all isolable molecules overhead—that is, viewed in their ethereal atmospheres—may be ranked, if they

have not attained the fulfilment of the cosmical law in respect of form by being spherical already.

Hence the first case of union is that of prolate with oblate molecules, so as to develop the spherical if they be already assimilated as to surface. If they have not been assimilated as to surface, then the most urgent case of union is that of non-metallic with metallic, that they may be assimilated, or, at least, while they remain in union, merge their differences in this respect by their fusion.

But here it may be justly remarked, that without a solution of both, or at least a penetration of oblate by prolate as axial matter, sphericity cannot be approached by a couple merely, nor even symmetry attained. The first of such binary combinations that can be symmetrical and isolable, or possibly aeriform, must consist of two, and hence a sanction, so far at least, for the doctrine of modern chemistry, that all aeriform units are coupled molecules. Thus, since hydrogen, as has been seen, is prolate, and is known to be positive, while oxygen is known to be negative, they will unite. But there could be no such aeriform unit as HO. In order to full individuation such binary combination must couple again, which, writing the symbols symmetrically, will give HOOH = H**O**H = H_2**O** = H_2O of the common notation. And here it may be remarked in passing, that very oblate or negative structures like oxygen, in order the better to fulfil the cosmical law and approach the spherical, couple when they can. And thus the aeriform unit of O is **O**, consisting of two atoms, its volume under the cosmical law, assimilated and consequently equal to that of hydrogen and azote and others; as aeriform units generally are, at least in simple dichotomous ratio, such as 1 : 2 : 4 : 8, &c.

When the aeriform state is not attained, or condensation takes place, then the molecular unit is no longer

the binary, no longer the aeriform unit, be what it may. In order to attain the spherical as nearly as possible, the aeriform units unite again into molecules composed of many aeriform units, which, when they are isometrical or undifferentiated on the poles, are either 4, 12, or 20, or $12 + 20 = 32$, these numbers being determined, not merely by the particular shapes of the aggregating atoms as being the numbers generative of the spherical, but because they are the number of ethereal elements constitutive of the nucleus of every material element (sect. 38); whence every molecule, by the action of the law of assimilation, is called upon by a chorus within itself to construct itself so as to consist of these numbers.

It is well known that organisms, in proportion as they become larger and more capable of enduring fatigue without dissolution, become more and more differentiated, or constituted of a greater variety of dissimilar parts. Although composed of little else but water, yet how curiously, and otherwise how inexplicably, differentiated by variety of organs is a Medusa! And in the mammalia, what preserves the ovum as a solid amid the liquid of the womb (which is known not to be devoid of solvent power) often for many months? It is because all the time it is receiving more and more differentiation. New and different organs are all the time being added to those that were before them. And here we see one of the reasons of the complication of organisms, and why a philosopher should not complain if he finds that the digestion of his food costs him more trouble than it does to an Amœba.

58. Organic differentiation and the molecular system in this planet culminate in the construction of the cerebral, or rather myo-cerebral system.—Along with comparative stability as a concrete, there are gained many other advantages by differentiation or multiplication of tissues and organs. And ultimately there is

constructed a tissue and organ capable of repeating in the material sphere, and that much more powerfully, that synthesis in which the material system took its rise in the ether of the celestial spaces—namely, the complete unification of ether into monads so powerful that, unlike the monads generated in the centre of the nebular speck, which are actuated only by attractions and repulsions, those monads, of which the most highly differentiated organism is the parent, though still ethereal as to their substance, are actuated not merely by attractions and repulsions, but by desires and aversions, and sooner or later by all the phenomena of mind.

Nor are the mental beings in which the material system effloresces and fructifies normally transient like the organisms which exist for their sake. Previously, indeed, they existed as separate elements of ether or light, and therefore, if they possess the fatal power of withdrawing themselves from the ever-living source of unity in creation, and of losing His unity-preserving influence, they may, under the law of heredity (calling for their lapse into ether again), secularly suffer dissolution, and after existing in a sad state (unless opportunity were afforded them of seeking to the source of unity and life) they may vanish from creation as sentient beings.

And thus the material œconomy, an unavoidable incident perhaps in creation, but a beautiful cloud-work in the azure of the spirit-world, is made its own redeemer, the mother and nurse of beings capable of enjoyment, suited, as soon as they put off their mortal coil, for entering the world of spirits. And thus is the grand cycle of creation completed. What was given to creation originally by the Creator, after a departure from the fulfilment of His design, yet by a development of harmony and exquisite beauty, returns to the world of spirits and to the Creator Himself again.

CHAPTER XI.

ON THE PRINCIPAL TISSUE ELEMENTS, AQUEOUS MATTER AND AMMONIA, WITH THEIR ANTECEDENT AND GENETIC PRINCIPLES AND RESIDUA IN THE LABORATORY, SULPHUR AND OXYGEN AND OXYGEN GAS, ZOTE AND AZOTE AND CARBON.

59. The bitetrad.—Our first stable molecule, the tetrad, the important position of which in every molecular system is shown by Boscovich,[1] is not to be expected in the free or uncombined state in a cold dense planet such as ours, but only, if at all, in a region of intense heat, where matter is very rare and consists of tetrads only, and molecular structures are dissociated and refined to the utmost, as, for instance, possibly high in the atmosphere of the sun and stars. If a single material element come in the way, the two (the tetrad and the atom) unite, as has been shown (sect. 42), and constitute an atom of hydrogen. But if pressure or other cause bring two tetrads near enough to unite, this they may do symmetrically by the apposition of their bases, in which case there will result an element almost isomorphous with hydrogen, its poles identi-

The Bitetrad.

[1] Theoria Philosophiæ Naturalis, &c. Auctore J. Boscovich. Pars ii. sect. 329.

cal, and differing only in this, that in each of the angles of the trigonal equator there are two atoms in the bitetrad instead of the one in hydrogen. Whence the bitetrad is capable of extending its axis so that it may become a trigonal prism terminated by trigonal pyramids, while hydrogen must always remain pyramidal without a prismatic part. For its literal symbol (seeking some type which is in the hands of the printer already) we may take ♅, the astronomical sign of the planet Uranus; its resemblance to H, the sign for hydrogen, showing the affinity which there is between the two elements themselves.

60. Sulph and oxygen; sulphur, oxygen gas, and ozone.—The form of the bitetrad departs farther from the spherical than that of hydrogen. It is more prolate or positive; it is therefore more restless or active when existing alone. But it is not under the same necessity to exist alone. Its equatorial elements, inasmuch as they consist of coupled atoms, are dissimilar to its polar elements, which consist of one atom only. Bitetrads existing in the same medium will therefore tend to unite by their dissimilar parts—that is, poles to equators. And thus there will be generated, all through the resulting molecule, triangles of forces, which will secure an intimate equilibrium and a general stability.

And what are the simplest numbers in which bitetrads may combine so as to construct a symmetrical molecule? Inspection will show that this lowest number is 5. But 5 may unite symmetrically, and give rise to one or other of two very remarkable structures. In one of them the bitetrads are united poles to equators, so that the axes of all are both parallel to one another and to the axis of the resultant structure. (See fig. S.) In the other they are united poles to equator as before, and their axes parallel to each other as before, but lying obliquely to the axis of the resultant structure. (See fig. O.)

The atomic weight of both these new elements is the same—viz., $2 \times 4 \times 5 = 40$, hydrogen being 5, and therefore 8 when H is assumed as 1. But both of them depart from the spherical farther than the bitetrad itself.

(S) *Sulph.*

(O) *Oxygen.*

(**S**) *Sulphur.*

(**O**) *Oxygen Gas.*

They will therefore both of them be very active chemical agents, and this their simplest state is not that in which they will be found free in nature or the laboratory. It is to be remarked, also, that they depart from the form of inactivity or repose (the sphere) in opposite ways. S is

prolate or positive; O is oblate or negative. Suppose a medium, then, in which both coexist, they will unite; and it is easy to see that a host of molecular structures will be generated, on which it would not be suitable for us even to touch here. Let us therefore, as we have done with respect to tetrads and bitetrads, suppose a homogeneous medium consisting wholly of atoms of S; they may obviously, after the example of hydrogen, correct their too positive or prolate form by uniting into tetratoms (see fig. **S**), which tetratoms will be much more stable than those of H, inasmuch as the three equatorial atoms of S pierce to the very centre of the axial atom, and all four are held together by many points of union. But the form is now highly negative or oblate. It now resembles O in this respect, and its atomic weight is $4 \times 40 = 160$, *i.e.*, 32 when H = 1. Now, have we not here the very atomic weight, and an explanation of the seemingly anomalous properties of sulphur hurrying, as it tends to do, into union with oxygen on the one hand, and with hydrogen and other metals on the other; and what not on both hands?

As to O, plainly its atoms will greatly improve their condition as to sphericity simply by the normal process of coupling on the same axis (see fig. **O**). By this their activity must be greatly lessened, and their fitness for the aeriform state greatly improved. In this state the atomic weight of **O** is $2 \times 40 = 80$, *i.e.*, 16 when H = 1. And have we not here a representation of oxygen gas and a solution of its anomalies also? And are not the agreeing yet contrasted properties of sulphur and oxygen in relation to each other happily explained by this molecular development of both, and of their respective functioning under the same cosmical law? Nay, what has been advanced is but a little that is illustrative of their relations. Thus, so oblate is **S**, that in rising into the free aeriform state, as is well known, three

atoms of S rise into the same unit volume, though at a higher temperature they are dissociated.

The natural aeriform of sulphur is not with an atom of sulphur but with an atom of hydrogen on each pole.

Sulphuretted hydrogen

$= SH_2$

61. Ozone.—The tendency of sulphur to rise into the aeriform state in triplets occupying one aeriform volume is not a wholly singular phenomenon. It has been lately found that **O** tends also in certain circumstances to acquire an accession of half its normal weight (aeriform ozone), thus giving as the aeriform unit OOO, homologous with **SSS**, but ever tending, in our atmosphere, to lapse into **O** + O; thus presenting to nature, though happily in very small quantities, the single atom of oxygen, this stimulus to life, but often corroder and universal parasite, in its most active form.

62. Aqueous matter.—In order to the genesis of the substances of the last paragraph there must be, as has been shown, a rare homogeneous medium composed wholly of bitetrads. Now, considering the facility with which hydrogen makes its appearance everywhere, such a purely tetradic medium must ever have been and ever be of small extent and of rare occurrence in nature. In

fact it has been shown that a group of five tetrads, simply by separation, constitute four hydrogens. Specks of ethereal condensation, therefore, in a medium of tetrads will develop hydrogens; and wherever there are bitetrads, hydrogens may be expected to accompany them. The production of sulphur, therefore, and of oxygen, in the way that has been given in the last paragraph, is not the normal course of the development of the molecular system of nature. But it was fair to touch on sulphur here, as it is an important chemical agent, and in this primer we shall not meet with it again.

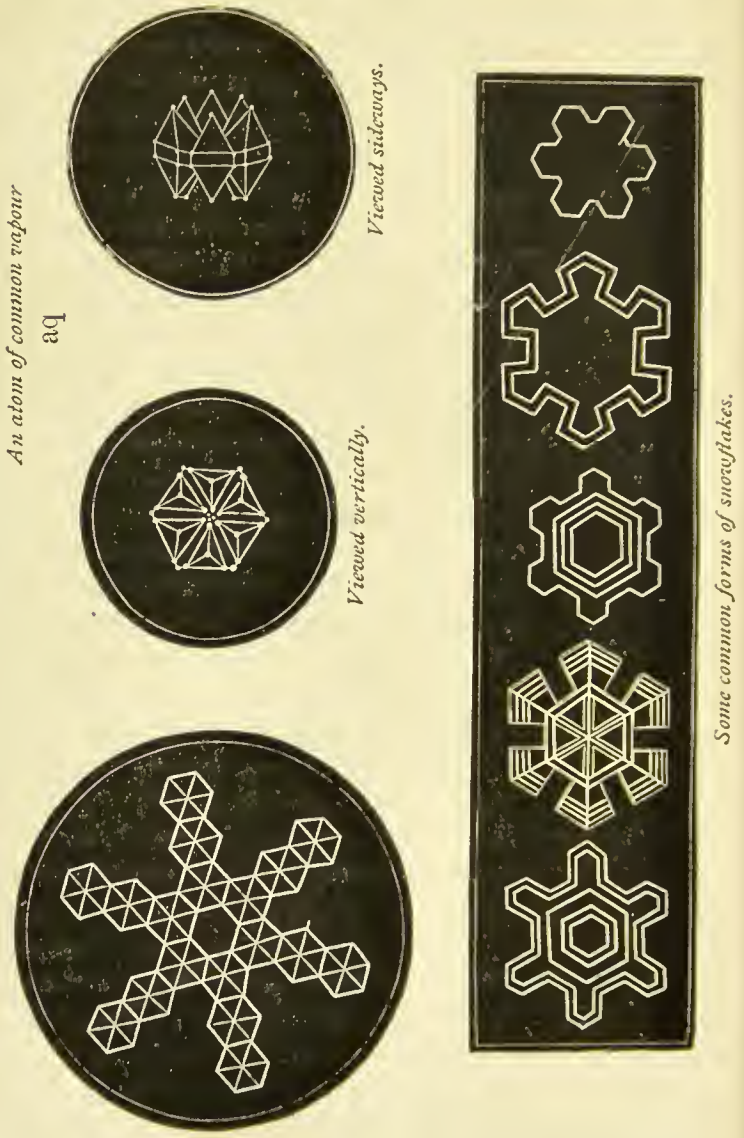
In order to find the normal course of nature, we must consider how bitetrads behave when hydrogen is present where they are. But, first, let us say a word as to how they behave when oxygen is present, both for the sake of chemistry and because it has been seen that oxygen may be a very primeval element. Looking, then, at oxygen in the free state—that is, a coupled atom or unit volume of oxygen gas (see **O**, p. 75)—it may be observed that it is wholly defective in its polar regions. They are, in fact, concave or re-entrant. An atom of H in each pole would plainly improve them greatly; and since **O** and H are so dissimilar, it is only to be feared that HH will plunge in upon the centre of **O** with too much force and cause a transformation. But say that they do not, then to save the trouble and expense of woodcuts, as before, and as we have adopted a dash or figure 1 as a symbol for hydrogen, so now let us adopt a figure 8 as the symbol for oxygen, which, as it happens, is both its atomic weight on the hydrogen scale, and not a bad representative of its section at right angles to the axis. In this way we obtain, as the product of the union of hydrogen and oxygen gas, the symmetrical molecule—

$$-88- \text{ or } \begin{matrix} | \\ 88 \\ | \end{matrix} \text{ or } \begin{matrix} H \\ O \\ H \end{matrix} \text{ or } HOH \text{ or } H_2O$$

Its atomic weight on the hydrogen scale is $1 + 8 + 8 + 1 = 18$, and if each of the outstanding atoms of hydrogen on the poles retains its aeriform volume, while the medial atom of **O** lies in the interval between them, its unit volume will be double that of hydrogen, and its specific gravity in the aeriform state will be the half of 18 —that is, nine times that of hydrogen, under the same temperature and pressure. Now, does not all this accord wonderfully with the most modern views of chemistry as to the composition of water? Whether it explains the place of water in nature, or many or even any of its wonderful powers and properties as it is seen functioning in nature, is another question. Meantime what has been shown should, I think, prevail with the adept in chemistry to show some respect for, or, at least, to look into, my method, especially when the experimental method, considered as insight into nature, is so much at its wits' end. Nevertheless, however much to the disadvantage of my views in the present day, I fear I must give up this, the chemist's, theory of the constitution of water almost if not altogether. Perhaps, indeed, such a structure may exist in regions of great cold and calm. But nature points to another structure as that of the least element of aqueous matter or an atom of common vapour. And to the development of this let us now proceed.

63. Common vapour.—Suppose, then, a rare medium, consisting in the main of bitetrads, but in which atoms of hydrogen make their appearance, the question is, What will be the first molecular structure resulting, which will fulfil the cosmical law in a manner so superior to others that we may expect it abundantly in nature as compared with them? Looking to the atom of hydrogen, then, we see that there are on it five regions suitable for the union and attachment of some other element, such as the bitetrad—three on its equator

and one on each pole. This structure, when existing in the highest temperature it can stand, must have the



form of the hexatom of hydrogen (fig. p. 52), and under the ever-operating law of assimilation may be expected

to occupy the same aeriform volume as marsh-gas (fig. p. 53), or H_2O—that is, a double volume as compared with H or O. But as the region in which it has been generated cools, or pressure increases, it can condense into a much smaller and more compact form, and one which fulfils in a wonderful way cosmical law in many of its clauses. The six nearly isomorphous and therefore harmonious elements of which it consists may place themselves so that the axes of all of them shall be parallel and the equator of all of them ultimately in the same plane as in the first two diagrams on the opposite page (both being badly drawn as to the positions of the equatorial atoms). Here, then, we obtain a structure at once of exquisite tenderness and stability, and which, if it represent anything, may be regarded as the first "resting-spore" of the molecular system.

That structure, consisting as it does of six separable parts, shows that it must be tender. But the atom of H entering into the circle of HH_5 differentiates it, and so tends to hold it together. Being so compact as compared with the same elements in their most fully expanded state, we may expect its aeriform volume to be half what it was then, and therefore assimilated to the surrounding elements in the atmosphere—that is, the same as that of H and O, and, as we shall see, of N. It has, then, two successive aeriform volumes, in this respect resembling sulphur, acetic acid, &c.

Now, does this new molecular structure, let us ask, represent anything in nature or the laboratory? And in answer, first let us inquire what is its atomic weight. Now that is plainly $HH_5 = 5 + (5 \times 8) = 5 + 40 = 1 + 8 = 9$ when $H = 1$. Its aeriform specific gravity is therefore nine times that of hydrogen. In this respect, then, it agrees with common vapour!

And here, supposing that it does represent common vapour or steam, a cause is indicated for those terrible

explosions of steam-boilers which are so frequently occurring and which so often seem unaccountable. Thus, from what has been said as to the dimorphous character of this structure, implying that at a certain high temperature each atom suddenly assumes a double volume, the raising of steam in a boiler, up to a certain temperature, must render it explosive to a degree far beyond that which depends on its density and heat merely.

Further, the appearance of this structure, so like an element of lace-work, resembles very much that of organic structures and material structures in general when they are sliced as thin as possible and seen through the microscope. But what comes nearer a verification, when looked right down upon (see the middle diagram on the left and that below it, on p. 80), it looks very like a minim snowflake. It reminds us also of the ternary arrangement of the fructification of monocotyledonous plants as compared with dicotyledonous plants, in which an aqueous instead of a carbonaceous tissue prevails.

And here a remark occurs having important bearings on a preceding paragraph (sect. 60). From that paragraph it is inferred that, in a rare medium, composed wholly of bitetrads, nothing could be developed but sulphur and oxygen, and consequently sulphuric substances; and that although hydrogen should be admitted, and unite with the oxygen and generate aqueous matter, still quantities of sulphur would remain, which, as a primeval element, does not accord well with our theory of the end and aim of creation, inasmuch as sulphur, though in small quantities it is an organic element, yet in large quantities may be regarded as physiologically useless, and when in union with hydrogen deleterious in a high degree. But sulphur, when expanded and dissociated to the utmost by rarity or heat, gives as its constituent sulph, which, when further urged by the same conditions of existence, separates into five bitetrads,

which in sulph, indeed, are united only by their edges. By the complete expansion of sulphur, therefore, in the presence of hydrogen, there will result $H\overset{8}{H}_5$ = aq; so that from a primeval nebula, though consisting for a time of sulphur and sulphurics, there will result only common vapour.

64. The dimorphism of the aqueous element.—A verification as to our aqueous element, one into which the observer has a more definite insight, arises from its dimorphism. Thus, suppose there come in its way another element, of which the polar regions or those regions presenting themselves for union are not hexagonal but pentagonal, like those on the poles of the atom of marsh-gas (see diagram, p. 53), then our hexagonal structure and it, while they will tend to unite in consequence of being dissimilar, cannot do so in consequence of being so unconformable. How, then, will their union be accomplished? Considering the tenderness of our hexagonal element, it is easy to believe that when it and a pentagonal element rush towards union in the direction of their axes, the hexagonal structure, which is plainly very mobile, and has a weak side consisting of an atom of hydrogen merely, will undergo a transformation. The weak side, the atom of H, will be thrown out of the circle of six into the line of the axis of incidence and reaction, and the five atoms of $\overset{8}{H}$ will fall upon the pentagonal pole conformably to it, which they may do, constructing at the same time a symmetrical, oblate, or equatorial coupling-joint or life-buoy-shaped element, held together as a unity by no fewer than sixty points of union; in a word, an element which we have met with already as co-ordinate with sulphur—in fine, an atom of oxygen. Thus,

HO

when becoming fixed and entering into union with molecules of the pentagonal order (which includes the great majority,) our atom of vapour is transformed into one of HO. And although both sides have been hitherto regarded as identical, there is not, either in natural or laboratory chemistry, an equation of greater importance than

$$aq = HO.$$

HO set free, aided by the law of heredity, easily redintegrates aq; but even when the H and O meet, nay, H and O (if the temperature be high enough) though they have never met before, H being so dissimilar to O and so penetrative, will plunge into the heart of O (which comes to meet it) with such force as to shiver O and drive the axes of its five constituent bitetrads into parallelism with the incident H and with one another, and so to give the counter equation

$$HO = aq;$$

heat being generated by the plunge sufficient to satisfy the superior capacity or requirement of aq for heat.

65. Water.—The atom of vapour, consisting as it does of a set of six nearly isomorphous elements on the same level, of which five are bitetrads, their atomic weight = 8, and the sixth an atom of hydrogen, its atomic weight = 5, may be said to have a weak side. In this respect it differs both from oxygen and hydrogen. While the latter two aeriforms, therefore, except under the greatest pressures, may continue in the fully isolated or aeriform state, it may be expected that a comparatively low pressure will be sufficient to cause the atoms of common vapour to coalesce, thus gaining for aqueous matter in the aeriform state the name, not of a permanent gas, but of a vapour; and what is the form and structure of the aqueous molecule that must result? To answer this with convincing deductive detail would require too great a lengthening of this primer. Suffice it to say that the

region for union, the equator, in the atom of vapour being a hexagon, it is not suitable for forming small spherical molecules with a periphery closed on all sides. Hexagons, whatever their number, are suited for indefinite extension in planes which may indeed interlace with one another, but cannot turn round within a small compass so as to construct spherical molecules or cells. Aqueous matter is therefore suited in a peculiar manner for forming laminæ and tissues, and therefore for general use in forming extended organisms, consisting so far of non-brittle tenacious tissue. In fact, by following up the synthesis, it comes out that to form a spherical molecule of condensed vapour, no fewer than six times six atoms are required; and after all, it is not a molecule with a continuous surface that is constructed, but an open capsular form consisting of six aqueous ribs or meridians, so mobile as to sphericity, that it is only at a temperature (4° C.) that it is truly spherical, and occupies a minimum volume. And, curiously enough, that volume, when newly condensed from steam at ordinary pressure, has just the same relation to a single material element as the generating steam had to the number of material elements constituting it, which is $36 \times 45 = 1620$, so that a unit volume of water at boiling-heat gives about 1620 equal volumes of steam—an expansion far greater than is known in reference to any other substance—showing what the unit volume of water must be, and how minute each unit of vapour. I only add that the molecule of aqueous matter, like the single atom of vapour, is dimorphous, the two molecules possessing very different properties, the equator being—

$$AQ = aq^{36} = (OHaqHO)^{12} = 18.H_2O.$$

66. Aquæform ammonia: aquammonia. — The experimental chemist experiences no greater difficulty in his pursuit of exact analyses than to obtain possession

of a considerable quantity of mere or pure water. Let him distil water over and over again, if only the distillate have stood for a time, he finds ammonia in it. And how many millions of atoms of ammonia must there not be before our senses can make us aware of their presence! This phenomenon the popular chemistry, which maintains the solidity, simplicity, and non-developable character of the sixty-three chemical atoms, is obliged to ascribe to the previous existence of organic matter in the water, notwithstanding all the chemist's care to exclude it—a hypothesis which our view of nature would hail with satisfaction, if there were ground for it. At any rate it cannot but be provoking to the chemist that this substance, which it baffles him so much to obtain from what he regards as its elements—azote and hydrogen—should infest his purest water so persistently.

But ammonia is not so far to seek. The molecular theory here presented to the reader claims it as a product of pure water itself, and, immediately after common vapour itself, a primeval substance. In short, according to the views here advocated, the normal process of coupling of two atoms of reduced common vapour with the discharge of an atom of hydrogen, or the union of two atoms of reduced common vapour on the poles of an atom of hydrogen obtained from without, with the discharge of two atoms of hydrogen from within, gives the following equation :—

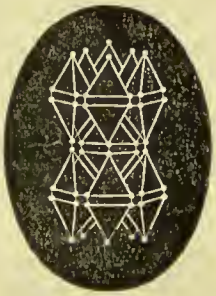
$$\text{The genesis of ammonia} \left\{ \begin{matrix} \text{AqAq} & -\text{H} \\ \text{AqHAq} & -2\text{H} \end{matrix} \right\} = \text{Am}$$

By reduced common vapour is meant its most symmetrical and statical structure, when its central group of material elements has been reduced from 11 to 6 by the development of the 5 which are supernumerary to the symmetry into an atom of hydrogen which may be given off—a process taking place abundantly in nature

and the laboratory, and lately recognised to a certain extent in chemistry as "the emission of occluded hydrogen." According to this view, ammonia has for

$$\text{Atomic weight} = \left\{ \begin{matrix} 45+45-5 \\ 45+5+45-(2\times 5) \end{matrix} \right\} = 85, \textit{ i.e.}, 17 \text{ when } H=1$$

Ammoniacal vapour, then, according to this view, is a double and therefore doubly powerful vapour, which may be expected to present homology with common vapour, as both exist and function in nature. Now this is eminently the case. Thus, being so different and yet conformable to each other, the two vapours ammonia and water rush together like $\frac{H}{H}$ and H to constitute common vapour, the most normal products being also homologous—viz. $H\frac{H}{H}_5$ and $AmAq_5$, though in the latter case there is no end of it. It is also well known that in heavy molecules ammonia plays the same part that water does in lighter molecules, acting the part of a hydrating element. But it is in constituting organic structures that the homology appears in all its perfection. Thus, in the zoic molecule, ammonia holds the same place that water does in the vegetal molecule.



Aquæform Ammonia.

But how, it may be well asked, can a structure so like aqueous matter, and derived from it by such slight change, give, on decomposition, azote instead of oxygen? To perceive that this ammonia cannot yield oxygen, it is only necessary to study the difference between common vapour and that which enters into the constitution of ammonia, and which I have called reduced vapour—vapour from which an atom of occluded hydrogen has been given off. In consequence of this, each of the five bitetrads, which, along with the constitutional atom

of hydrogen constitute the reduced vapour, has lost an atom from its equator. Constituting two of the angles of that equator there are two atoms; constituting the third—the angle in the centre of aq—there is only one. Hence, through their dissymmetry, these five defective bitetrads must continue to cohere at the centre to support each other as they are now doing. They cannot leave each other and turn round so as to unite poles to equators, which is needful to the genesis of an atom of oxygen. From the decomposition of ammonia, therefore, oxygen is not to be expected.

67. Zote.—When the atom of hydrogen has left the hexagonal system in which, along with the five bitetrads, it constituted an atom of vapour, the latter, when reduced as has been described, in the atom of ammonia, can neither leave their present engagement, so as to construct an atom of oxygen, nor can they form a symmet-

Zote ⏀ = Z

Hydro-carbon.

Azote ⏀ = Az

rical structure at all. If they close at one pole they must open wide at the other. And thus there results a structure with one closed and one 5-partite polar region, dissymmetrical in the highest degree, plainly a hemiform, reminding one of the tetrad itself, though it is trigonal, while this is pentagonal. It must therefore be active in the highest degree. But it cannot be isolable by itself,

and therefore, if known to the chemist at all, can only be known in a state of union, but, like the tetrad elements of this kind, may couple, and that very inseparably, when nothing interferes. Thus we obtain two new elements.

68. Azote.—When destroyed, an atom of ammonia will, of course, give them coupled. (See the diagram on the right.) Its atomic weight is 2 reduced $Aq - 2H = (2 \times 40) - (2 \times 5) = 70$, *i.e.*, 14 when $H = 1$. Now this is the atomic weight of azote. In its form it is eminently spherical, and it is empty in its centre, or cellular, and in its internal structure it is eminently reposing or statically constituted. In nature, therefore, when let alone, it must be eminently permanent and reposing, or, in chemical language, inactive. Now in all these features it represents azote. And thus we see the beautiful homology there is between the two constituents of the atmosphere. They are both coupled elements. And on this fact it rests that they are both capable of remaining permanently aeriform, with only moderate activity, whether mechanical or chemical, while yet they both enclose a store of potential energy, such that, if the two particles of which each consists were opened up and parted from each other's embrace, universal destruction of organic life would ensue. Still the hemiform being so active, and therefore, when rightly introduced, such a stimulus to life, I have named by dropping the privative letter of azote—a term which in these pages refers to a definite structure—thus reserving the term nitrogen for this same element when it is not known whether it exists as zote or azote, and, I will add—

69. Antizote.—To illustrate the meaning of these new terms, and save trouble and expense in woodcuts, let us take as a symbol for zote the pharmaceutical mark for 20 grs.—viz., ℈ or ϑ. Its form will serve to remind of the hetero-polarity of the atom of zote, one polar region

of which is closed and the other cleft (though with five points instead of three, as in the apothecary's symbol). This granted, it is obvious that the positions of the two zotes in azote may be inverted. They may possibly cohere by their closed poles. And thus there will result an atom of what we may call

Antizote $\overset{\text{DG}}{\text{DG}}$

It would not indeed be so natural as azote. But to effect differentiation in the midst of homogeneous azote, and possibly in the atmosphere, some few elements of this structure might be brought into existence. And its physiological action until it was resolved into azote, as it speedily would be, would certainly be the very opposite. It would certainly be most injurious to the organism; while, in consequence of its immediate return into azote, under every possible manipulation it could not have been detected by any of the chemical trials of the air which have been hitherto practised.

Thus, when steadied by the placing of an atom of carbon on each of its 5-fid poles, this antizote constitutes the basis of the most active poisons,—viz.

Cyanogen $\overset{\text{OGO}}{\text{OGO}} = \text{C}\overset{2}{\text{Z}}\text{C} = \text{CN}$ chem.

70. Atoms, their relations with metallicity.—In connection with zote and elements in general, possessing one or more 5-fid poles, an important feature in our molecular morphology comes out, which it is desirable to notice even in this primer. I allude to that condition which affects both the appearance and the functioning of elements, and has long since served and still serves for their classification into non-metallic or metalloidal and metallic. Suppose a structure whose whole surface

consists of elements presenting 5-fid poles to the incident light, then it is to be expected that that light will be repelled from it and reflected and refracted with much greater force than from a surface composed of elements with closed poles such as azote or oxygen. For in this case there is, as we might say, an atmosphere above the general concrete periphery, consisting of single units of matter each invested with its complete atmosphere of ether. The upper or outer surface of such a structure, therefore, is assimilated to the ether itself in the highest degree that any material surface can be. Isolation, therefore, between it and the ether incident as light will take place (sect. 25) to the greatest degree possible—that is, it will repel, reflect, or refract light in the highest degree; in other words, it will be most lustrous or metallic. When, on the contrary, the surface of a structure consists of elements with closed poles, the material elements must exist in groups of three or five, deprived, it may be, of much of the ether proper to their genesis, and all lying on the general surface of the molecule. Being comparatively so dissimilar to the ambient ether the incident light will not be repelled to the same degree, and instead of intense reflection or refraction there will be a tendency in it to penetrate the mass and render it less lustrous, translucent, or transparent. As to the respective functioning of the two classes of elements, the most obvious must be their general demand for union, the union of non-metallic or metalloidal with metallic, and that simply, and in the first instance, in consequence of the great difference that there is between them.

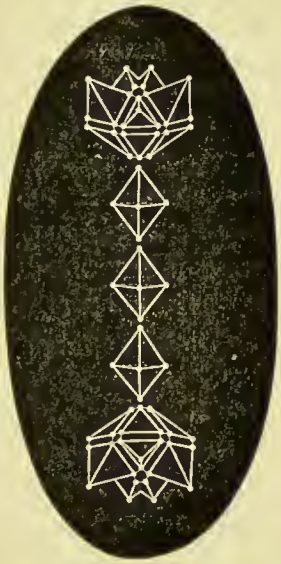
The atom of zote thus possesses the potency of both metallic and metalloidal (oxygen and fluorine are the only non-metallics). Azote is metalloidal; antizote is metallic. Now both are symmetrical, and therefore possibly aeriform. Azote constitutes four-fifths of the atmosphere, and happily is lustrous compared with oxy-

gen, which constitutes the remaining fifth. But along with these the spectroscope detects, though in the smallest quantity, a metallic element, the light emitted by which is affirmed to be the same as that emitted by lithium, and it is consequently judged to be lithium. Now of lithium the atomic weight (H = 1) is seven; and that is the atomic weight of our zote. May not the atoms of both these possess the same structure, while the great difference in their mode of genesis and their whole history (zote, aerial and organic, lithium mineral merely) will explain by the law of heredity any differences in their habits and functioning? Zote having been first given to nature in union with hydrogen, will prefer this element to oxygen. Lithium having been first given in union with oxygen, will prefer oxygen again. It may be remarked, however, that having been satisfied as to hydrogen, zote has a demand for oxygen too, as in the amines of the laboratory; and even where no carbon is present, as in hydroxylamine. As to the lithium of the laboratory, it is obtained after a very severe ordeal only, in the concrete molecular state of differentiated dodecatoms (sect. 74), which it is not to be expected that any heat that we have tried could dissolve so as to show lithium in the coupled elements of the aeriform state.

71. Zotammonia.—There can be no doubt that the atom of aquammonia (see fig. p. 87), as it exists in living tissue, is supported by three atoms of aq, one on each alternate facet of its equator or waist, and these in their turn supported and steadied by six atoms of carbon symmetrically applied to their equators. (That this is not a merely morphological construction or an unacknowledged hypothesis, will presently be shown by chemical analysis.) But when thus equatorially charged, the axis of the structure is too short. The form is oblate. Under the law of sphericity, therefore, the axis will

tend to lengthen. Now this it may do without destruction of the tissue, simply by the transformation of the axial atom of aquammonia into an atom of zotammonia, the three aq with their carbons now adhering to the three equatorial edges of the central atom of hydrogen.

Zotammonia.



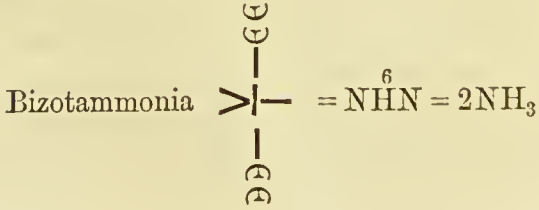
$Z\overset{3}{H}Z = NH_3$

Additional to the equatorial charge of water and carbon, an atom of carbon will now plainly tend to settle on the poles of each of the zotes. The whole structure will then be fixed or dead, and possibly stable enough for enduring the earlier stages of organic analysis in the laboratory. It consists of $CZH_3ZC + 6C + 3aq = C_8H_6NO_3$. Now this is precisely the formula which C. Schmidt found for the matter of the muscles of the most muscular of creatures—viz., insects! Such structures will, however, form into dodecatoms or icosatoms, giving the two classes of chemical formula for proteine. But my object here is to show the singular value of ammonia as an element in a highly vitalised organism. It can lengthen or shorten its axis. It can change a

spheroidal molecule from oblate to prolate; and a fibre consisting of a moniliform series of such spheroidal molecules, it may both shorten and lengthen as a function of organic life, and so keep a heart beating or make bones approach each other or separate.

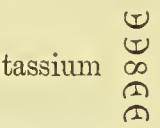
72. Bizotammonia: bizote.—Two atoms of zote may obviously couple in either of two ways. Their 5-fid poles may face each other and touch at the equator of the coupled form, thus locking up the possible metallicity of zote in the interior, so that in this case the structure is a metalloid. It is also eminently symmetrical and spherical, and suited for the free or aeriform state. It represents azote, as has been shown.

But two atoms of zote may couple on thimble-wise or in parallel positions, and in this position the combination may be very stable, for the 5-fid pole of the one is precisely a mould for the closed pole of the other. This couple we may call bizote. And by the use of this more stable structure there are produced in the laboratory those ammonias of which the axial body is the hexatom of hydrogen (see diagram, p. 52), and which are as fixed, as aquæform ammonia is mobile and transformable, and which are therefore useless for the purposes of life. Their structural beauty and stability are, however, very great. It is not wonderful, therefore, that they are great favourites with the chemist, and a very cat's-paw for substitution without destroying the type. With the printer's type already in use, we may thus attempt to represent this admirable structure:—



73. Potassium, sodium, lithium.—And here, were we to go into details, it would be seen how close and natural is the relation of the volatile with the fixed alkalis.

Suppose, then, instead of a hexatom of hydrogen as the interior of an atom of the most stable ammonia, there is simply an atom of oxygen as a coupling-joint between the two atoms of bizote, which will thus still constitute the poles of the new element: then this being so, it may be expected to function in the laboratory like ammonia; but it will differ in this respect, that while a body of hydrogen must be easily dispersed, and the structure which it holds together easily decomposed, so perfect is the fitness of an atom of oxygen to function as a coupling-joint when convex pentagonal poles, such as those of zote, are inserted into its negative poles, which are perfect moulds for the closed pole of zote, that this new structure is not to be expected to be decomposable in the laboratory.

Potassium 

Moreover, its atomic weight—according as all the four zotes that enter into the construction of one particle are all crude with the atomic weight of 8, when H = 1, or one or two of them purified or reduced to differentiate the structure—its atomic weight is $5 \times 8 = 40$, or 39 or 38, the mean 39. Now this is the atomic weight of natrium, ridiculously named potassium, whose wonderful agreement in its action with ammonia is constantly remarked; while, physically and analytically, it has seemed hitherto to differ in every particular.

Suppose, again, that, instead of double zotes or lithiums in the poles of the atom of oxygen the coupling-joint, there are only single atoms, there will plainly be an

analogous element whose atomic weight, according as it is crude or fully reduced, will be $8+8+8=24$, or $7+8+7=22$; or, when half reduced so as to be most perfectly differentiated, and therefore most stable, is $7+8+8=23$. It therefore represents

Sodium 

If, again, as the medial body, instead of a single atom of oxygen there be a coupled atom, the functioning of the structure while in this, the free or aeriform state, will be analogous to that of sodium. But it will admit of being dedoubled, and the hetero-polar or non-symmetrical structures resulting may form into coupled molecules, each half of which is an oxide of a metallic element whose atomic weight when purified is seven, and which, therefore, represents

Aeriform lithia 

74. The density of substances deduced without the use of the balance.—Here, by reference to the alkalis in their concrete state, an illustration may be given of a remarkable verification of our molecular morphology. From the structure of the material element or atom of nature itself, as also from observing the forms of the regions for union in the molecular elements constructed of this,—atoms which, with but one exception (water), are either triangular, as in hydrogen, sulphur, silenium, and a few others—or pentagonal, as in oxygen, zote, carbon, and most elements—it will be seen that, when they condense and gather symmetrically round a common centre so as to constitute their condensed or dense state, the group completing the form must consist of twenty or of twelve particles—a beautiful form, of which the

linear skeleton or ideal is either the icosahedron or the dodecahedron, the two most perfect of the regular polyhedra or Platonic bodies. It is to be remembered, however, that such structures are eminently spherical and homogeneous. They are therefore, under the cosmical law, insecure as concretes. They are ready to liberate their constituent elements into the more fully individualised, the aeriform state. To retain them in the concrete state, especially in order to survive the ordeal of mundane or laboratory action, they must be made to depart from the spherical and the homogeneous. They must be differentiated. Now this is most easily and symmetrically done simply by the doubling of the constituent particles, on the poles of one of the isometrical axes of the molecule. By this, eminence is given to that axis, and a centralised and conservative course to the specific heat and other physical currents of the molecule. In this way a monometric dodecatom will be steadied by being made to consist of fourteen instead of twelve particles. Let us further add that the cosmical law of assimilation leads us to expect that the units which impart individuality to the molecules of solids and liquids, no less than in the case of aeriforms, will occupy assimilated volumes—that is, volumes either equal or in simple dichotomous ratio, such as 1 : 2 : 4 : 8 : 16. In chemistry, indeed, it has been lately assumed that the unit volumes of all aeriforms are fully assimilated or equal. But such absolute uniformity would be contrary to the whole economy of nature, of which the characteristic is unity in variety, sameness with difference. The volume of an aeriform unit depends on its ethereal atmosphere as well as on the weight of its atomic nucleus. Equal variations in the volumes of dissimilar gases, accompanied by the same variation in the volume of the thermometer or the pressure, may perhaps indicate that in equal volumes of these gases and vapours there

are the same number of aeriform units; but as to the composition of these units, the number of chemical atoms of the same kind into which each aeriform unit may possibly be separable, the phenomenon referred to says nothing.

As the unity for the specific gravity of aeriforms is naturally common air, so that for condensed aeriforms, whether solids or liquids, is naturally water. Air and water, so abundant everywhere in nature, both in former epochs and in this world now, must have exerted and still exert a powerful assimilative influence upon unit volumes subsequently formed or still forming. I have shown reason for assuming that the unit of ice consists of a differentiated dodecatom of water with an atom of water in the centre—that is, of fifteen atoms of water occupying sixteen volumes. The mineral kingdom, then, has range enough for the unit volumes of its elements, having ratios on its opposite extremes of 1 : 16.

The unit of water (sect. 65) = aq_{36} = 1620 = 9 × 36 = 324 when H = 1. Adopting the hydrogen scale as most familiar, we obtain as the specific gravity of the alkalis the following table, which is copied from a small volume accessible to the public since 1868. How long it may be before scientific chemists mind it remains to be seen. The author has given up hopes of it in his own day. Happily he does not need such consolation.

Lithium, $\mathfrak{Li}$ . . . $G = \frac{Li^{14}}{\frac{1}{2}AQ} = \frac{7 \times 14}{\frac{1}{2} \times 324} =$ ·60 Exp. ·59

Sodium, $\mathfrak{Na}$ . . . $G = \frac{Na^{14}}{AQ} = \frac{23 \times 14}{324} =$ ·99 Exp. ·97

Potassium, $\mathfrak{K}$ . . . $G = \frac{K^{14}}{2AQ} = \frac{39 \times 14}{2 \times 324} =$ ·84 Exp. ·86

$$\text{Ammonia, } \left.\begin{matrix}(\text{GG})\\ \text{H}^6\\ (\text{G})\\ \text{H}^3\end{matrix}\right\} \ldots G = \left.\begin{matrix} = \dfrac{\text{Amm.}^{14}}{2\text{AQ}} = \dfrac{17\times 2\times 14}{2\times 324}\\ \\ = \dfrac{\text{Am.}^{14}}{\text{AQ}} = \dfrac{17\times 14}{324}\end{matrix}\right\} = \cdot 73 \text{ Exp. } \cdot 7+$$

"As to rubidium and cæsium they are baric and barytic potassiums respectively; while thallium comes out as an icosatom of sulph (sulphium analogous to selium or metallic selenium) with an atom of sodium locked in each pole ($\text{Tl} = \text{Na S}^{20}\text{Na}$). Its molecule appears to be that which is most prevalent in the mineral kingdom—viz., a compound dodecatom occupying 8 aqueous or half an ice-volume, thus:—

$$\text{Thallium } \ldots G = \frac{(\text{Tl}^{12})^{12}}{8\,\text{AQ}} = 11.\ 44 \text{ Exp. } 11. +"\ ^{1}$$

75. Carbon, hydro-carbons, oxy-hydro-carbons.—A single atom of zote (see diagram, p. 88) may symmetrise itself and become capable of individualised existence, and of moving about, by the movement towards the line of its axis, of the five atoms now constituting its 5-fid pole, and by the construction there of an atom of developed or aeriform hydrogen, instead of the atom occluded in constituting the 5-fid pole. This residuary structure, given to nature in union with an atom of hydrogen, has for its atomic weight $35 - 5 = 30$, *i.e.*, 6 when $\text{H} = 1$. It will presently appear how completely it represents carbon.

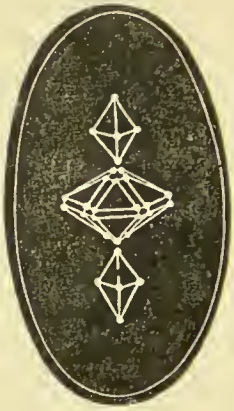
The same element may come out of unreduced zote. This atom, consisting of 5H, can symmetrise by assimi-

[1] See 'A Sketch of a Philosophy,' Part II. p. 96 (the last page). Williams & Norgate: 1868.

lating its 5-fid to its closed pole, opening at the same time at the equator. We thus obtain a minute metallic element which we shall not here investigate but merely signify by the letter X, which may be regarded as somewhat resembling it. Now of this form the axis under the law of sphericity is too short, it will therefore, as in the former case, tend to develop the matter of its two 5-fid poles into an atom of hydrogen on each pole, a short pentagonal bipyramid lying between them the same as formerly, and which is figured in the diagram named nascent marsh-gas.

Biberyllium.

CH_2



Bihydride of Carbon.
Nascent Marsh-gas.

Now there are many features in this new bipyramid which point it out as representing carbon. It is true, that though the atomic weight of carbon was long, and in the best days of philosophic chemistry, taken as six, it is now more generally taken at twelve, which is the weight of a coupled atom. But this is easily explained. The single atoms are so flat or oblate that, like oxygen, &c., they will, when free, usually go in couples under the law of sphericity. Besides, there has of late been a disposition in chemists to double

almost all atomic weights, which has just removed them twice as far as they were before from any possible insight into their nature and relations.

More important than the fluctuations of chemical hypotheses it is to remark that, according to the genesis assigned to carbon, this element is of a residuary kind. Before it can be given to nature, two atoms of hydrogen must have left the parent $5\overset{\circ}{H}$. Now, compared with all other elements, hydrogen, for its quantity of ponderable matter, has by far the most perfect atmosphere of ether. This, then, in this case it must have taken from what it left behind. It has carried off the wings of that atom. Hence the ethereal atmosphere of carbon is too defective to allow it to ascend into the aeriform state or to liberate carbon-atoms from cohering together, except by the help of hydrogen or oxygen, or something else.

Add to this what has just been insisted on, that carbon is first developed or given to nature in union with hydrogen, and it will be found that the functioning of carbon in nature and the laboratory beautifully explains itself.

It has seemed very strange that certain nebulous appearances in the celestial spaces should give light in the spectroscope as if coming not merely from hydrogen but from nitrogen, but stranger still, from hydro-carbon. Now the view here given of the comparative stability of hydrogen and nitrogen, and the genesis of hydro-carbon from the latter, resolve the mystery. When extreme heat or the demand for partitionment to occupy a vacuum exists to the utmost degree possible, of all molecular structures, hydrogen will be the last survivor, or at any rate the last but one (the tetrad) not isolable at the earth's surface. And after hydrogen, that which fulfils most perfectly the cosmical law by its sphericity and cellularity, and consequent repose and exemption from change, is azote. Azote is, however,

as we have seen, liable in certain circumstances to invert into antizote. And of this the normal educt is the first symmetrical hydro-carbon, the doubling of which gives an atom of olefiant gas of the same type with marsh-gas (see diagram, p. 53), but with doubled carbons on the poles.

Antizote $\overset{\text{CC}}{\text{HH}}$ = $\overset{|}{\underset{|}{\text{OO}}}$ nascent olefiant gas = $\frac{1}{2}C_4H_4$.

Marsh-gas, whose diagram has just been referred to, holds a most eminent place in the molecular economy. Thus, tetrads, when under pressure and existing in sufficient numbers (instead of merely coupling into bi-tetrads, and, along with hydrogen, giving birth to the organic elements), and when compelled to group symmetrically round a common centre, must do so to the number of 20, thus constituting an icosahedron, which is eminently spherical, and so far fulfilling the cosmical law. But instead of being cellular, and fulfilling it in this respect also, there is a group of 20 material elements in its centre, one belonging to each of the 20 tetrads of which it consists. It may therefore be compared to a round seed with an embryo, or matter bent on a specific development within it. Now 20 atoms of matter, when most fully developed and individualised, give a tetratom of hydrogen (see diagram, p. 52). Moreover, the surface of the icosatom—the coat of the seed—which consists of 60 atoms, or two parts of 30 each, in connection with each pole, when opened symmetrically like seed-leaves, and these parts, consisting of 5 triangles of atoms, come close to the axis by their loose points so as to be assimilated to the polar regions which remain undisturbed, constitute 2 atoms of carbon. So from this *quasi* seed, under pressure or in the bowels of the earth, when developed under the cosmical law and its

own specific heat secularly actuating it, gives the following equation :—

Crude Silicon. *Marsh-gas.*

This hydro-carbon is so perfect under the cosmical law in every respect—sphericity, cellularity, differentiation —that, though so tenuous in structure, it possesses great repose or stability. Not only can it exist in the atmosphere without being liable to the attacks of oxygen, but, maintaining its integrity while on the poles of many other hydro-carbons generated in the strata, it preserves them also, and gives the rock-oils to nature; for, as has been frequently stated already, it is the poles of molecules that chemical action usually attacks.

76. Oxides of carbon with hydrogen.—The 5-fid hollow polar regions of the atom of oxygen (see diagram, p. 75) are precisely moulds for the short pentagonal pyramids which constitute the polar regions of the atom of carbon. They are therefore perfectly conformable while they are at the same time different. Carbon and oxygen will therefore readily unite.

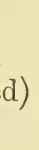
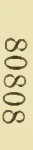
In the case of oxygen gas, when it comes into a region where loose atoms of carbon exist in moderate quantity, what is to be immediately expected is the filling of both the external poles by an atom of carbon in each. This forms a symmetrical structure, having many analogies with azote, but exactly double the

weight, and with a longer axis. We may expect it, therefore, to occupy a double volume. Its specific gravity will therefore be the same as azote. It is plainly an atom or molecule of carbonic oxide COC = C_2O_2, or in prevalent notation, CO. And in this structure we see the basis for the first products of vegetable nature.

Thus, supplying an atom of H to each pole, we obtain the saccharine element found in vernal sap, &c. Its molecules are manifold and subject to many modes of differentiation on the poles. The simplest molecule of all is the simple dodecatom of CHO.

A coupled saccharine  Its molecule, $C_{12}H_{12}O_{12}$, a sugar.

Let the atoms of H on the poles be carried off by the incidence of **O** on each, while one atom of H, by being placed in the centre, is conserved, there results, as in simplest vegetations :—

Oxalic acid (monohydrated)  = C_2O_3HO. And  in oxalates = C_2O_3

But if hydrogen do not secure a permanent position, the whole organic world is for the time omitted. The carbon poles of the coupled atom of carbonic oxide, as soon as a unit of oxygen gas can reach them and open into its two constituent atoms by heat or otherwise, are immediately covered by the oxygens possibly with the genesis of 2 aq. And thus mailed in oxygen both on the poles and equator, the carbons are secure from all further attacks of this parasite. And now we have a molecular element which possesses great perfection of structure. Its form is no doubt prolate,

though its axis is scarcely longer than that of carbonic oxide. But as, in consequence of the structure of our molecules, it may be said that there is a spiral spring between each couple of the constituent atoms, the axes of molecules can be lengthened or shortened to as great extent as the law of sphericity may dictate. Supposing it to exist as an aeriform, its volume may be expected to be the same as that of carbonic oxide, that is, two atmospherical unit volumes. But it will be heavier than nitrogen or carbonic oxide in the ratio of 22 : 14, and therefore more than $1\frac{1}{2}$ times heavier than common air.

Carbonic dioxide $\overset{\text{OOOOO}}{\text{OOOOO}} = \text{OC}\mathbf{O}\text{CO} = 2.\text{CO}_2 = \text{CO}_2$ chem.

If it cannot depress its axis so as to be spherical, it is much in its favour that it is cellular, the vacuole between the two equatorial atoms of oxygen being empty. As it has poles similar to one another, and the polar element doubled for its equator, while it is differentiated in the intermediate regions by two elements which are dissimilar to the polar and equatorial matter and yet similar to one another, the whole structure is at once symmetrically constructed and its parts beautifully balanced. Hence, it may be easily understood that it should be difficult to decompose it in the laboratory. But when nature offers an atom of hydrogen to each pole, as is probable on the incidence of this substance on the vegetable tissue when apt for receiving it, nothing more easy than for the medial oxygens to escape as a unit of oxygen gas, while what remains goes immediately into the tissue or remains on the surface as saccharine matter.

Carbonic dioxide with hydrogens on its poles $\left.\begin{matrix}\\ \\ \end{matrix}\right\} \overset{\text{OOOOO}}{\text{OOOOO}} = \left\{\begin{matrix} 2\,\overset{\text{O}}{\text{O}} \ldots \text{Saccharines} \\ + \\ \text{OO} \ldots \text{Oxygen gas} \end{matrix}\right.$

77. Carbonic dioxide.—It is obvious, however, that the dioxide which we have been considering is a coupled atom without any bond between its two parts but that which apposition and the law of heredity impart. Under many conditions of existence, therefore, it may be expected to dedouble, while each of its two parts will be no less, if not more suited for the aeriform state, than they were when coupled.

Carbonic dioxide (a single element)

$=OCO=CO_2$

In this case, in fact, there is obtained an aeriform element almost isomorphous with oxygen gas, only its interior or stomach, not now empty, but filled and weighed down by that substance which, of all the organic elements, is most opposed to vitality. Its physiological relations must now, therefore, be entirely changed from those of oxygen gas. But since its poles are still isomorphous and wanting in matter to fill them, it may be expected to be like oxygen, a parasitic element, or element tending to settle upon others. Accordingly there is a strong analogy in the appearance and place in nature among stones, between those which are mere oxides and those which are carbonates of oxides; while, except in those cases where the metallic element is already mailed in oxygen on both poles, and thus protected from its further attacks, as in silica and alumina, oxides tend, when carbonic dioxide comes in the way, to grow into carbonates, the latter being more symmetrical, consisting as they do of five members, an atom of oxygen both in

the equator and on each pole, separated, and the structure differentiated, by an atom of carbon and one atom of metal lying between. The most interesting feature in this minim element of carbonic dioxide is its equivalence to oxygen gas in volume and form, and its complete dissimilarity to it in its relation to vitality. The oxygen, though its interior is now filled with a deadly element, may yet pass through and find egress from the organism by any channel by which the vitalising oxygen may have entered. And accordingly, oxygen having found its way into the blood through the lungs, and having picked up the used and effete carbon in the blood, escapes from the lungs again and leaves the blood ready for receiving a fresh charge of oxygen, vitalising the organism by the very act by which itself becomes charged by the death-producing element, which (clothed in oxygen so that it shall not hurt *in transitu*), it immediately carries out into the external air, there to become the food of the vegetable kingdom.

78. Carbonic acid.—In the actual chemistry, carbonic dioxide and carbonic acid are supposed to be the same molecule, or at least substances differing only by the absence or presence of water. But the theory of molecules of this work, together with the power which it imparts of calculating the specific gravity of the masses from the atomic structure of the molecule, has led to the discovery that the dioxides of carbon and of silicon, in important parts they play both in the organic and mineral world (so beautiful as pearl and crystal), are not simply CO_2 and SiO_2, but differentiated dodecatoms, each eight times the weight of a single atom of dioxide, and yielding eight such when in construction or when broken down. Moreover, carbonic, silicic, and phosphoric acids, whose place in nature is so analogous, exhibit in the light of our theory a form and structure which are homologous.

CHAPTER XII.

THE THEATRE FOR LIFE : THE OCEAN—THE AIR—THE SOLID SURFACE OF THE GLOBE.

79. The Ocean.—Of material media our molecular synthesis gave a world of common vapour (which we called the first "resting-spore" of nature), and, of course, of water in a central region. Our theory of the genesis of the elements is, however, such that in a region of aqueous pressure condensation will give other elements in the water. Of these, as may be inferred from what has been advanced (sect. 73), two that are very early to be expected are sodium and potassium, of which the latter has an axis so long that the cosmical law of sphericity must tend to shorten it. Now this may be done by individualising its 5-fid or metallic poles into atoms of hydrogen, and giving them off, by which the poles of the potassium become similar to carbons. It is therefore now a metalloid instead of a metal. And as we saw that the atomic weight of potassium, when fully reduced, might possibly be 38, or even lower, so this its residuary metalloid, having given off 2 atoms of hydrogen, will be 36, or even less. The axis of the atom of sodium being much shorter, it will continue as a metal when potassium has been demetallised. These two will therefore now be eminently dissimilar, and will hurry into union with one another. When separated by chem-

ical analysis, the demetallised element, with the atomic weight of about 36 when H = 1, which may be expected in the aeriform state to constitute a green vapour like potassium itself, and which, as it has carbon-like poles and a long axis, may be expected to function like carbon, though much more powerfully, represents chlorine. So that what we have found developed in the world of waters is chloride of sodium, or sea-salt. Supposing this salt to exist in isometrical dodecatoms, we obtain, as its specific gravity,

$$\text{Rock-salt, . . } G = \frac{(NaCl)^{12}}{AQ} - \frac{12(23+36)}{324} = 2.18 \text{ Exp. } 2.15.$$

That the ocean must contain many other elements in smaller quantities I have elsewhere shown (see 'Sketch of a Philosophy,' Part III., "The Chemistry of Natural Substances," p. 71).

80. The Air.—It seems, on first thoughts, a very difficult problem how to obtain an atmosphere for our world in which hydrogen may be expected to be given off everywhere, and to be ready everywhere to rush into union with oxygen, and cause it to lapse along with it into common vapour. But no doubt a single atom of oxygen will be safe in the presence of hydrogen, if both its concave poles be filled by an atom of azote, for whose convex poles those of oxygen are precisely a mould.

Now we have seen that the relation between aqueous matter and azote is very close. Thus, we may easily conceive that there may result in the heat and pressure of the abyss the combination

AzOAz,

which will form into differentiated dodecatoms, and escaping from the pressure of the abyss, and coming up, will break up into 24 atoms of azote and 6 of oxygen gas, with a small excess of oxygen—that is, 4 volumes of azote with 1 of oxygen gas, with a small excess of oxygen. Now this

is the well-known constitution of the actual atmosphere; and thus its composition is accounted for, which has been hitherto regarded as unaccountable, inasmuch as four-fifths of it seem to consist of a purely useless substance.

81. Rocks and Sands.—For a world which is to be a theatre for living creatures, not only fluid media such as water and air, in which they may swim and fly, but a solid surface also, on which they may run about, is highly desirable. And such is the provision which is made for them in the terraqueous globe.

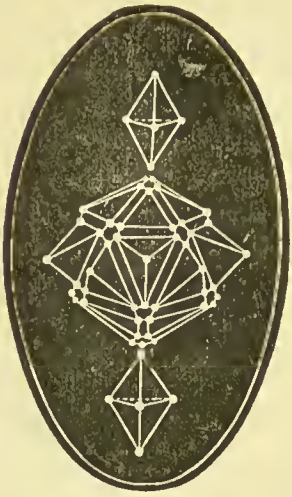
When condensation into water has taken place in the centre of a globular nebula of vapour, the pressure in the central parts of that water must by-and-by become so great that the aqueous matter must undergo transformation into denser elements. The tetrads into which every element (except hydrogen) is ultimately dissolvable, must pack themselves together more closely. In this way molecules are given to nature suitable for forming for the world, when it has become cellular, a permanently solid surface or crust. In this place we shall illustrate this only in reference to a single mineral species, which, however, is at once that which our theory suggests as the first and most important, and that which nature presents to us in the greatest abundance.

It has been already stated, and immediately appears from the form of the tetrad or triangular pyramid itself, that when elements of this form are pressed together, or aggregate symmetrically around a common centre, 20 must concur to complete the form. When they unite, with summits centrad, there results a metalloidal element whose form is icosahedral, of which a diagram has already been given (p. 103). At that place it was shown how that element, by the most complete expansion and individuation of the 20 units of matter in its interior, might be developed into an atom of marsh-gas, and gain the aeriform state, and ultimately become an

important member in vegetation. But the 20 units in its interior, in being repelled from each other by their specific heat, must usually pursue a much simpler course. They must radiate symmetrically and similarly from the centre outwards, until, having passed through the centre of the triangles on the periphery, they stop at the same distance above it, as the original central position was beneath it. Thus the position of the 20 tetrads has become inverted. Their summits, instead of being centrad, have become peripherad, and the molecule, from being metalloidal, has now become metallic. But it is now cellular, and as spherical and homogeneous as possible. It has therefore fulfilled to the utmost the cosmical law. Its constituent tetrads have become entitled to individuation, and to occupy each its own separate place in space. This molecule, therefore, as soon as it is constituted, is on the eve of explosion—food for the volcano. We are not, therefore, to expect that it has ever come into the hands of the chemist. But that it may be preserved in nature, all that is necessary is that it shall be differentiated in its structure, and its cellularity will be very favourable for its perpetuation. Let it then be actuated along any one of its six axes by one of those linear currents of force by which nature is everywhere traversed, and let the 5 units of matter on the poles of that axis, at present constituting 2 atoms of coronal or occluded hydrogen, be raised up into two atoms of aeriform hydrogen, and the molecule will be most effectually differentiated, the polar regions being metalloidal, and the equatorial region metallic. Its atomic weight is now $(20 \times 4) - 2 \times 5 = 70$ —*i.e.*, 14 when $H = 1$. It therefore agrees in atomic

Explosion.

weight and semi-metallic character with silicium. And if this hydride could maintain itself in nature, plainly



Nascent Bihydride of Silicium.

Binoxide of Silicium. Silica.

it would double itself like nascent marsh-gas (see diagram, p. 100), and constitute

Hydride of silicium, $SiH^4Si = SiH_4$ chem.

But on the first attack of oxygen gas, plainly the hydrogens on the poles will be carried off by the nearest atoms of oxygen that are incident, and lapse along with them into aqueous matter, while the second elements of oxygen in the coupled atom will perch upon the poles of the silicium, and fix themselves there. Thus we obtain an atom of silica, the most abundant substance in the mineral kingdom, bringing aqueous matter along with it, both together to constitute

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